JUNE 1958

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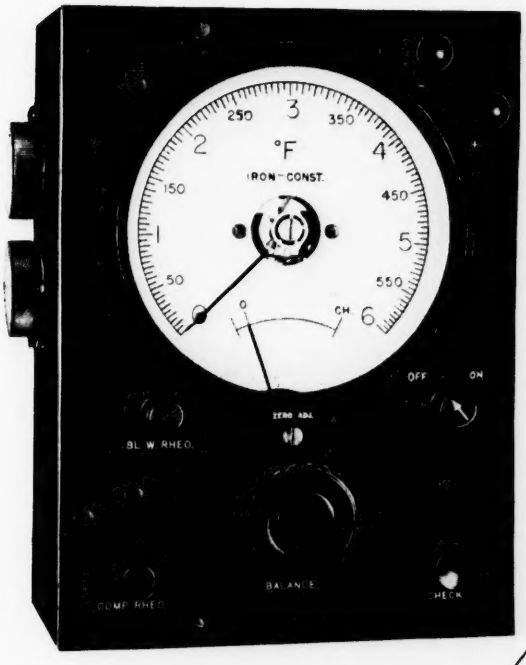

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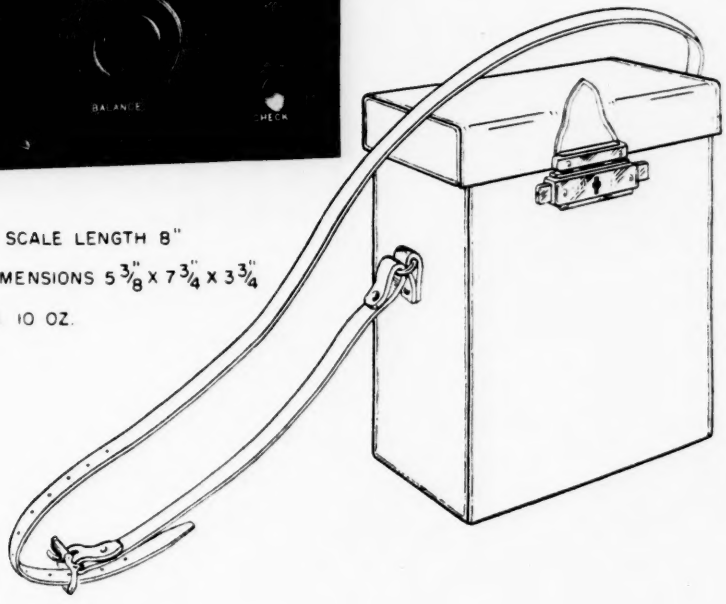

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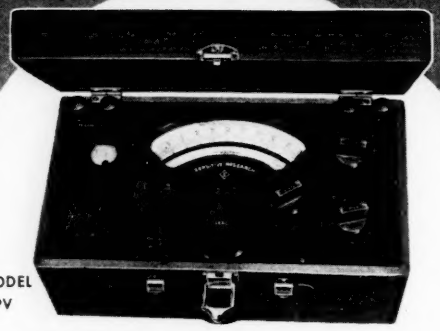

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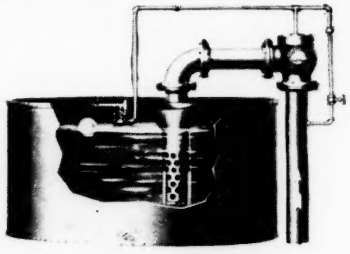

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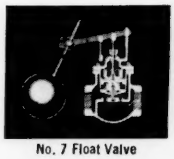

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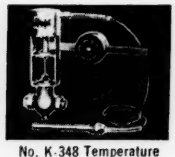

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JUNE 1958

31

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EDITORIAL

Significant Science for Secondary Schools, 1031

M. MARCUS KILEY—instrumentation shouldn't take a back seat in high-school science courses

FEATURE ARTICLES

Numerical Readout, 1032

A SURVEY of the three basic digital readout types

The Digiverter—A Digital Readout Converter, 1038

HORACE R. FINNEY—converts vertical decade counting readout into a horizontal Nixie in-line readout

What Price Computer Reliability? 1039

STANLEY ROGERS and JOHN McLEOD—measuring effectiveness of maintenance procedures

A Bilinear Approximation for Evaluating Square Root, 1042

LESLIE R. AXELROD—permits approximate evaluation of $\sqrt{A^2+B^2}$

Simulation, 1043

TELLS what each knob does and why

A Novel Thermostat for Hot Rollers, 1044

D. A. SENIOR—deducing temperature from resistance change of inductively-heated roll

A Digital Control Valve, 1045

T. GIZESKI—flow control by digital increments, without servo elements

Electrical Interference, 1046

JAMES C. COE—reducing the causes, types of remedial action

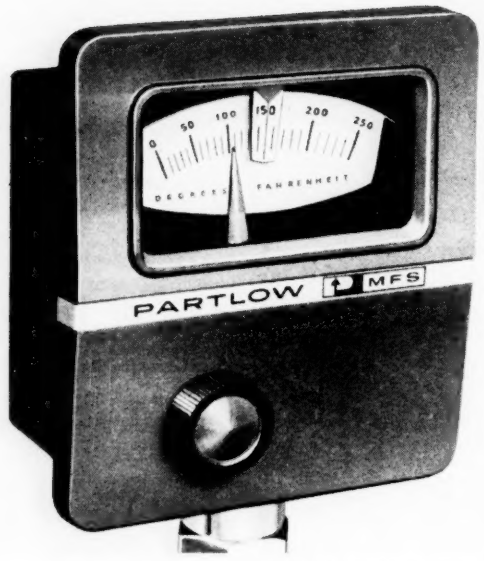
Electronic Circuitry, 1050

CHARLES KEZER and MILTON ARONSON—three more basic circuits

Automatic Emergency Valves, 1053

CHESTER S. BEARD and FRED D. MARTON—how they operate

Continued on page 962



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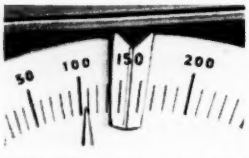

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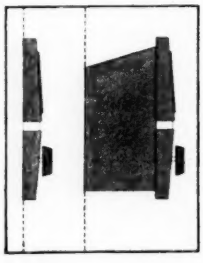

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INSTRUMENTS and AUTOMATION

VOL. 31, NO. 6 • JUNE, 1958

Continued from page 961

The Journal of THE SOUTHERN CALIFORNIA METER ASSOCIATION

Regulation Pitfalls, 1061

W. L. MASHETER—design of gas handling stations

THE SIMULATION COUNCIL NEWSLETTER

Application of Flow Graphs to Analog Computer Programming, 1063

An Evaluation of Series Summations on the Analog Computer, 1064

SOUTHEASTERN meeting at Georgia Institute of Technology

The Role of Electronic Analog Computers in the Simulation of Aircraft Gas Turbines, 1065

MIDWESTERN meeting at General Motors in Indianapolis

OTHER REGULAR FEATURES

Letters to the Editor	964	Panhandle Pete	1014
Trends	975	New Instruments	1068
News	978	New Plants and Mergers	1102
Briefs	984	People in the News	1103
Stock Report	1000	New Literature	1106
Events	1011		

Advertisers' Index 1118

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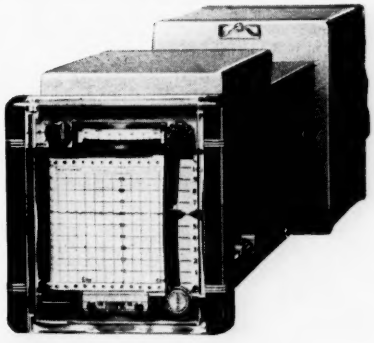

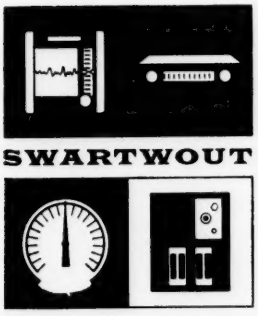

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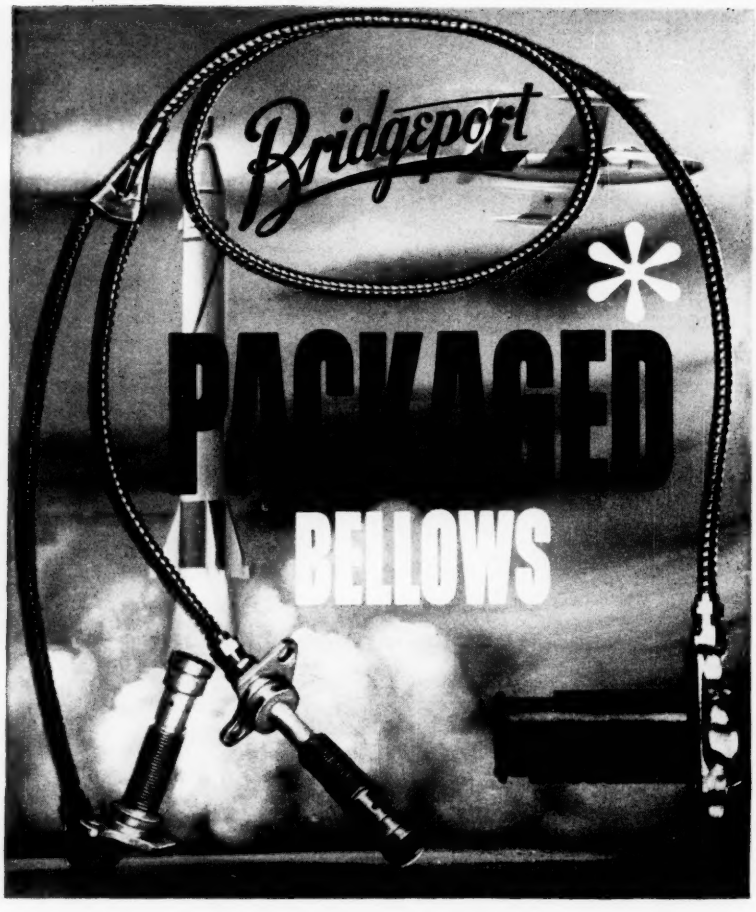

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to the editor

Editor, I&A:

May I send a few words of commendation for your high achievement with the course of study in automation you helped to establish in the Pittsburgh Public School System. I plan to go to New York to listen to Mr. Hoffmaster describe this project at the time of the 4th International Automation.

I have presented a paper on the significance of science in secondary schools before the superintendents of seventeen states at the conference of the American Association of School Administrators in Cleveland. Our approach to significant science teaching is so closely associated with the equipment of young learners with the proper instruments for making useful observations that I believe you may be interested in our point of view. Accordingly, I am enclosing a copy of what I have said in Cleveland with the hope that you may find it interesting since it touches a field of major concern to you. I should be happy to have your reaction to our interpretation of man inventing his own biological evolution by developing better senses for himself through instrumentation.

M. Marcus Kiley
Deputy Superintendent
Springfield Public Schools
Springfield, Mass.

Our reaction is good—and we publish these comments in a guest editorial on page 1031.

Editor, I&A:

It may be of interest to you to know that the Bucks County Technical School, now being erected, includes a course in Instrumentation. This has come about on the recommendation of representatives of industry from The United States Steel Company, Fischer & Porter Company, Rohm & Haas and Brown Instrument. It is our understanding that this is to be the first of its kind in Pennsylvania, since instruction is given on the secondary school level; therefore, we are looking to all sources for assistance and your name has been given to me as reference.

We are particularly interested in course material and of more importance, obtaining an instructor for this course. I am sure that if we could locate an instructor, the course material would be taken care of. To be eligible to teach in the technical

school, the instructor must have had a minimum of six (6) years trade experience in Instrument Repair and Systems Installation, and must have 24 college credits in Professional Vocational Teacher Education. It is conceivable that if we could find the right person with sufficient trade experience, we could employ him and have him obtain his professional credits after employment.

We certainly would appreciate your interest and assistance in an effort to provide this type of program.

George M. Schaffer
Principal
Bucks County Technical School
Morrisville, Penna.

Perhaps some of our readers are interested.

Editor, I&A:

May I have permission to reprint your thought provoking editorial which appeared in the February 1958 issue of *Instruments and Automation?* If possible I would like to use it in the following ways: (1) Distribute copies at our local P. T. A. and (2) have it reprinted in the local weekly paper (The Brighton Argus).

I hope you allow us to use this editorial for I feel that more of the general public should have a chance to read it.

Richard L. Levenick
President, Brighton Area P.T.A.
3437 Van Flamburg Road
Brighton, Michigan

We are delighted to give permission.

Editor, I&A:

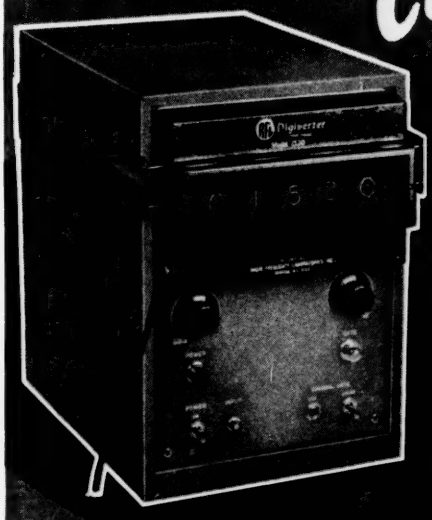
The "Subcommittee For Spelling Programing With One M," part of a larger "Committee for Publicizing the Rule for Doubling of Consonants," respectfully wishes to call your attention to the fact that the words programing, programed, and programer are spelled correctly with only one m. The spelling of these words is governed by the rule for doubling on consonants. This rule, used by all good writers, helps to keep our language from becoming completely chaotic.

The Style Manual of the United States Government Printing Office, page 59, expresses the rule.

You are invited to join hands with Subcommittee members to prevent the acceptance of the hideous, mispelled word: programming (Ugh!). Remember we do not wish to add to the list of exceptions already noted above. Be strong. Do not

Continued on page 969

Modernize your Counters*



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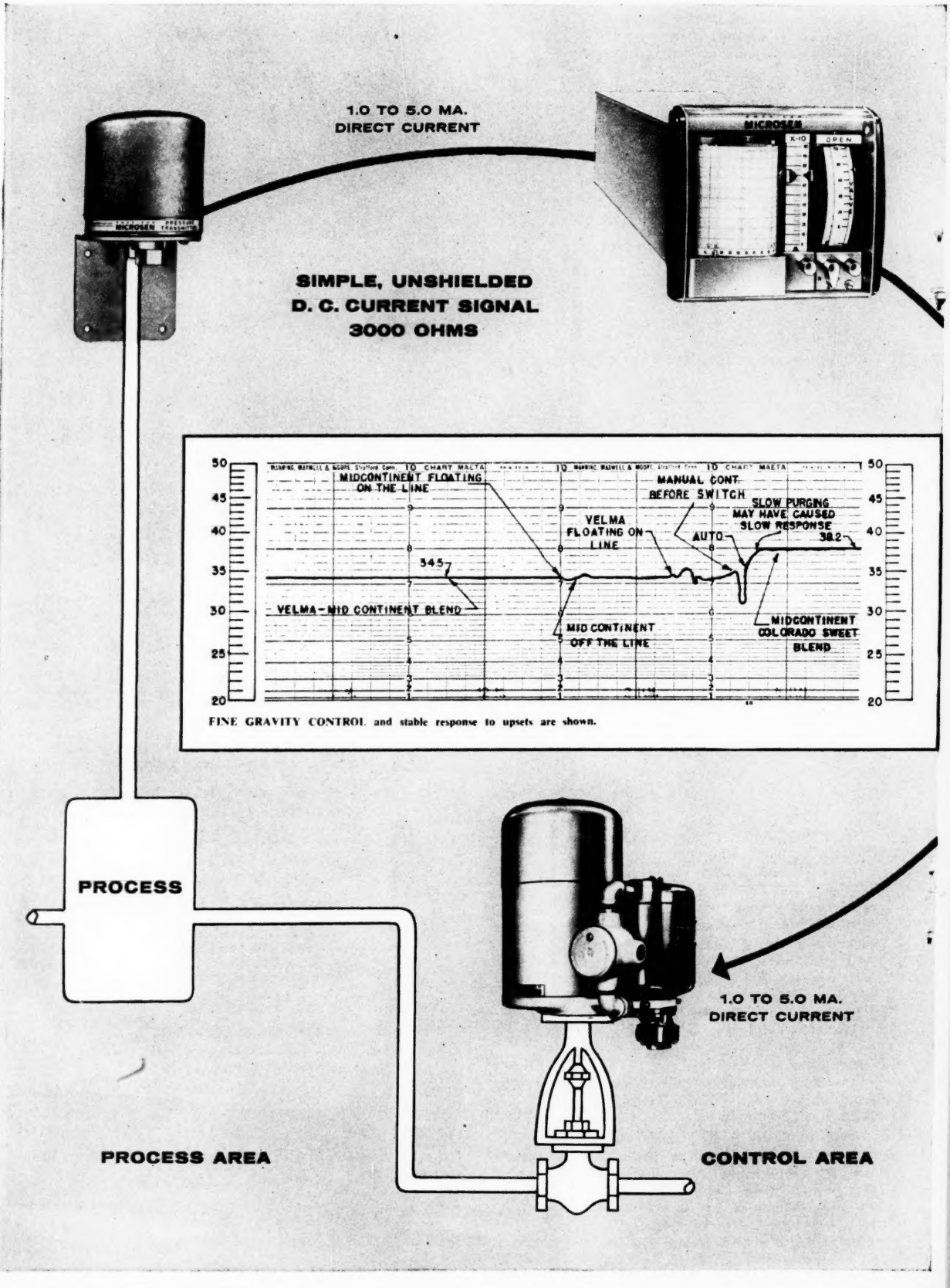

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waver when you are told that the British spell it with two m's and that they have a prior claim to the English language. They have a right to use two m's because their parent word, programme, also has two m's. Do not waver when you are told that words ending in x and w do not follow the rule. Words such as mix, fix, and box are not true exceptions because x is a redundant letter in the English language, standing for the double consonant ks. The rule applies only to single consonants. Words such as renew, hew, and saw are not true exceptions because the letter w is used in these words as a vowel, not as a consonant, hence does not require doubling.

Stand firm. Do not waver.

Ronny H. Cortes
Chairman, Both Committees
Long Beach, Calif.

Editor, I&A:

We know you are interested in accurate reporting, therefore, we must make a comment on the first paragraph of your "Trends" page in the April issue in *Instruments & Automation*.

This paragraph comments on the Australian instrument industry and the lack of instrument makers in that country.

Taylor Instrument Companies of Australia Pty. Ltd. with headquarters in Melbourne came into being in November 1953. This operation started off as an assembly plant making almost a complete line of Taylor instruments, but as time has passed, more and more actual manufacturing is being done in Australia and fewer parts are imported from London or Rochester.

Today they are delivering from Melbourne our complete line of Fulscope controllers for temperature, pressure and flow with parts largely manufactured in Australia. In addition, they are equipped to supply recording instruments for measuring most variables, dial thermometers, locally manufactured air strainers, air reducing valves, etc.

I am sure you will be interested in this correction of the impression that your article left with those interested in the industry.

F. S. Ward
Vice President
Foreign Operations
Taylor Instrument Companies

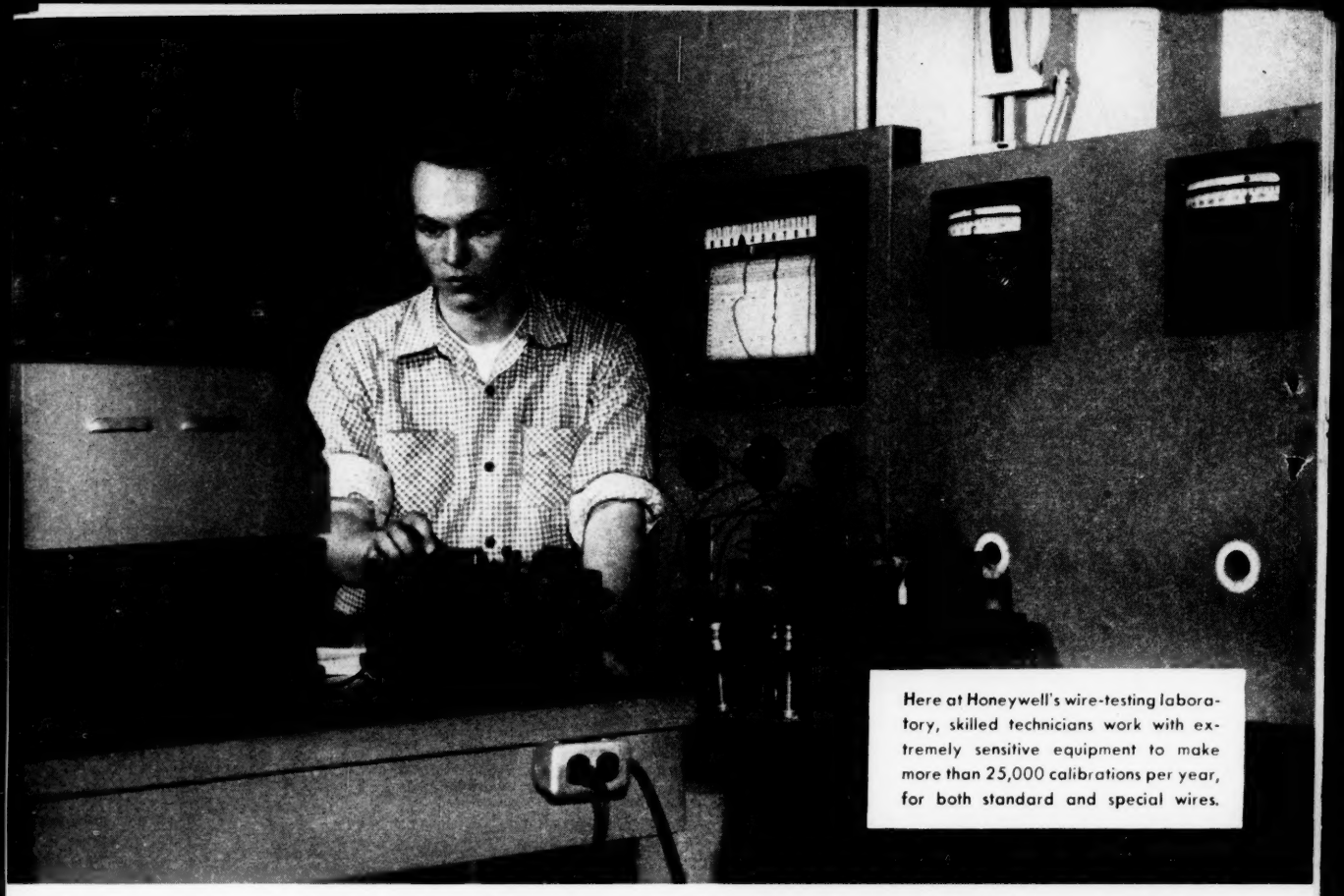
five-hundred hours of continuous pressure measurement at 600° F

Two unique CEC Pressure Pickups, the 4-316A and 4-317, now combine to offer a wide range of pressure measurements at extremely high temperatures. Designed for continuous operation at 600 F without cooling, both pickups operate on the unbonded strain-gage principle. Together they cover a pressure range of 15 to 5000 psi gage. The 4-316A is also available in differential (to ±25 psid) and undirectional differential models (0-150 psid). One-piece construction of diaphragm and case . . . machined from 416 stainless steel . . . assures that no foreign substances will come in contact with the measured media. Sizes are ⅜" and ½" nominal diameters for the 4-317 and 4-316, respectively . . . weights, 55 and 23 grams with mounting flanges. These features provide rugged, stable pickups for static and dynamic flight-load testing, engine studies, and supersonic tests where external cooling is not practical.
For other applications, a special cooling adapter extends the operating range of the 4-317 to 2000 F. Call your nearest CEC sales and service office for additional information, or write for Bulletins CEC 1568-X33 and 1588-X7.

Transducer Division
Consolidated Electrodynamics
300 North Sierra Madre Villa, Pasadena, California

RECOGNIZED LEADER IN GALVANOMETERS—TELEMETRY, PRESSURE AND VIBRATION INSTRUMENTATION

For more information circle **11** on inquiry card.



Here at Honeywell's wire-testing laboratory, skilled technicians work with extremely sensitive equipment to make more than 25,000 calibrations per year, for both standard and special wires.

Thermocouple Accuracy

...here's where it begins

The accuracy of your entire control system can depend on a single thermocouple wire. You can be sure that any Honeywell standard thermocouple or extension wires you use are accurate. They all meet or exceed ISA specifications.

If your application should demand *extremely* high accuracy, Honeywell can calibrate to your requirements, or even supply certification, at nominal cost.

Ask your Honeywell Supplies Man for details on special and certified calibrations, and for complete information on thermocouple and extension wires. Call him today at your local Honeywell branch . . . as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

Honeywell

H HONEYWELL *First in Controls*

Editor, I&A:

I am interested in determining if a potential presently exists for an organization offering specialized engineering services to industry in conjunction with perhaps a distributorship in the field of automation equipment:

1. Does a potential exist for an organization which can provide specialized engineering services to industry in conjunction to acting as a distributor or perhaps as a broker for the sale of the automation equipment?

2. In what specific field does this potential exist—machine tools, control instrumentation, automatic programmers, etc.?

3. Is this requirement perhaps presently being fulfilled by existing organizations or through franchised distributors?

Alex Petrovsky
Lafayette, Calif.

1. There are two types of services that can be offered to industry by a local agent—(A) consultation-type "systems engineering" on instrument and automation problems and (B) distributor for manufacturers of such equipment. The latter must perform some of the former's activities in order to make sales; the former often need some hardware in order to make expenses. Nevertheless, both types of services are needed and already exist to varying degree at various levels. Our January issue treats this subject in detail.

2. As to where the market are for pure consultation-type systems engineering, I refer you to several articles in our January issue on this subject. They are not encouraging for the small operator in one area; however, most equipment suppliers in the USA rely on local representatives and distributors, and thousands of such companies are in existance, in every local area of this country.

3. Although all requirements are being met in some degree today, there is always room for one more efficient and experienced operator.

It is necessary first to establish in what field you are going to operate. The basic fields are process instrumentation, electrical and electronic instrumentation and components, machine-tool equipments-components-instrumentation, business data and office equipments and supplies, etc. If you know the problems, plants, and people at work in one of these basic fields, your chance is as good as anybody's.

The finest general purpose temperature regulator in the industry. For the first time, you can get premium quality "extras" at no added cost. This new self-powered regulator is trouble-free, powerful and sensitive. Installation is easy and inexpensive. Large Sylphon® Bellows provides perfect stroke action for valves up to 4". Handles pressures up to 250 psi. Designed for extra-long life.

5 **new extras at no extra cost:**

1. **New Teflon Chevron valve stem packing**—no sticking, no leaking, no lubrication . . . ever!
2. **New Monel Valve Stem**—super-finished to prevent sticking!
3. **New "Quick-Detach" stem fitting**—valve removable without disturbing adjustments!
4. **New Design incorporates "MA" valve**—for "dead-end" service!
5. **New overrun assembly**—prevents regulator damage from overheating!

WRITE FOR BULLETIN D-LL

Mr Controls

Robertshaw-Fulton
CONTROLS COMPANY

FULTON SYLPHON DIVISION • Knoxville 1, Tenn.

For more information circle **12** on inquiry card.

Here's how General Electric solves typical DC power-supply problems

for computers and special applications

PROBLEM

"We need to devote our engineering time to designing our electronic circuitry . . . not the power components."

SOLUTION

This is a frequent problem facing computer manufacturers. General Electric's Rectifier Department has complete engineering and manufacturing capability not only to design and apply all types of power supplies, but also to incorporate power supplies into completely integrated systems.

These systems could include load distribution, supply sequencing, protection for power supply and load, and complete power distribution. Let General Electric tackle your DC power problems such as those associated with load IR drop, "cross talk," and other nuisance-type problems plaguing your engineers.

PROBLEM

"It's always a problem making sure transistorized equipment is safe from its power supply."

SOLUTION

To alleviate this problem, General Electric has developed several methods of making transistorized equipment safer in this respect. With G-E protective circuits, shorting a plus high-voltage bus to a plus or minus low-voltage bus would not cause the low-voltage bus to exceed a small percentage of nominal rated value.

General Electric power supplies protect completely transistorized pieces of equipment from large losses due to over-voltage failures.

PROBLEM

"My power supply requirements fluctuate so much . . . big jobs, little jobs, all in between."

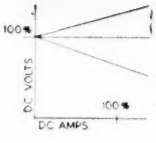
SOLUTION

G.E. has built individual power supplies and complete systems ranging from less than one watt up to 35,000 kilowatts. These power supplies span the complete range of DC power—regulated and unregulated—applying all types of components. G-E experience includes completely transistorized supplies, and supplies with the new controlled rectifier, magnetic amplifiers, voltage stabilizing transformers, and motor-alternator "brute force" systems.

PROBLEM

"We have a real low-voltage power distribution problem with our computer."

SOLUTION



Low-voltage distribution problems can be handledeasily through load compensation. Curve "A" is net desired no-load to full-load regulation at load point. "B" is regulation at load without remote sensing or load compensation. "C" represents IR compensation in power supply itself. "D" is amount of IR or load compensation.

If you have a computer or special power-supply problem, free your engineers of this problem and turn it over to General Electric for solution. It's more economical! G-E engineers can call on over 40 years of experience in the metallic rectifier field and put this experience to work in solving your particular problem—large or small. Contact your nearest General Electric Apparatus Sales Office or write Section E465-6, Rectifier Department, General Electric Company, Lynchburg, Virginia.

Progress Is Our Most Important Product

GENERAL ELECTRIC

For more information circle **13** on inquiry card.

Editor, I&A:

Congratulations on the many visual improvements you have made in your magazine. The February cover was particularly attractive.

Also, congratulations to you and your associates in Pittsburgh for the terrific job you have done with the Pittsburgh high school. I have suggested to Jake Groenewegen, ISA's new National Education Committee Chairman, that he become thoroughly familiar with this project and attempt to "multiply" its use throughout the United States.

Philip A. Sprague
President
The Hays Corporation
Michigan City, Ind.

Reader Inquiries

D-c Relay

Professional Engineer seeks sources of supply for relay capable of making and breaking 5-amp d-c power supply. To be actuated "make" by 24-v condition, and "break" by 30-v condition similar to fully-charged or discharges 12-cell battery. A-318

MPG Gage

Consulting Engineer is interested in contacting manufacturer willing to cooperate in development of dashboard-mounted miles-per-gallon gage in the range of approximately 1/30 GPM. A-319

Pen Ruling Machine

Paper manufacturer requests bids on fabrication of a laboratory model pen ruling machine. A-320

400-cycle Servo Systems

Design engineer with instrument manufacturer wishes to recieve information on complete system, or components such as choppers, amplifiers, motors, etc. Electrical, mechanical and cost information desired. A-321

Fine-gage Aluminum Wire

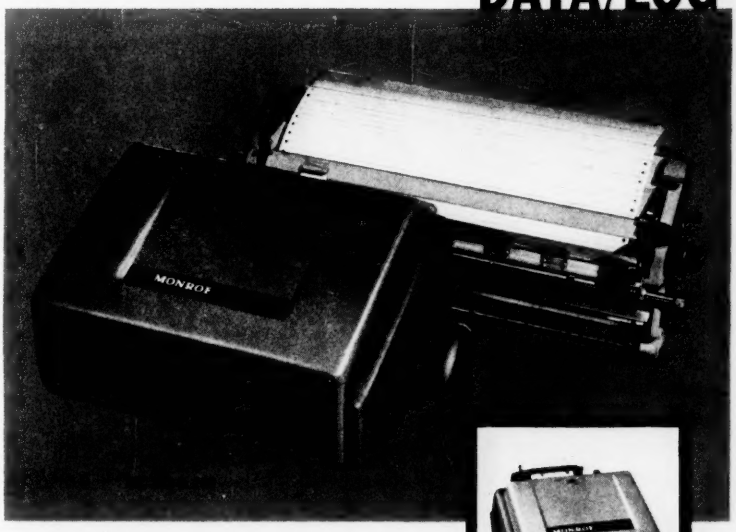
Consulting engineer wishes to contact manufacturers of fine-gage (46 to 49) aluminum wire (1) with enamel coating, (2) with anodized surface. A-322

Large-figure Printer

Swedish representative of scale manufacturer wishes to contact makers of large-size (1" or over) printing device to print on paper rolls, packages, etc. Impulses to be taken from digital readout such as digitizer or the like. A-323

NEW in Data Recording → MONROE

DATA/LOG



MC 202

NEW

...**PRINCIPLE.** Parallel entry DATA/LOG printers with automatically positioned carriages.

...**FORMATS** for printed copy.

...**CARRIAGES.** Programmable carriages accept narrow or wide forms up to 18 inches, with front feed carriages for card insertion.

...**CAPACITIES.** From three to 14 digits for each print cycle.

...**ACCUMULATORS.** Up to 4 accumulators with 14 digits each.

...**FACILITY.** Each DATA/LOG has its own control chassis, power supply, control relays, and timing pulses.

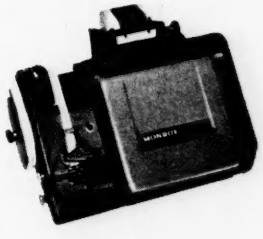
DATA/LOG PRINTERS INCLUDE:

Series MC 202, 13" or 4¾" fixed position carriage, with or without accumulators. Readout Speed up to 180 print cycles per minute.

Series MC 203 & 204 each provides up to 14 digits maximum, on an 18½" or 15¾" programmable tabulating carriage. Up to 150 print cycles per min.

Series 203 comes *without* accumulators, Series 204 is available *with* up to 4 accumulators of 14 digits each.

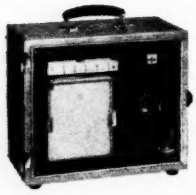
Series MC 205, provides 5, 6, 7 or 8 bit punched tape, with any coding for computer input. The basic printer provides up to 10 digits printout on a 13" or 4¾" fixed carriage, with or without accumulators. Two accumulators have 2 to 10 digits maximum each. 64 cycles per minute can be punched, and 140 cycles per minute printed.



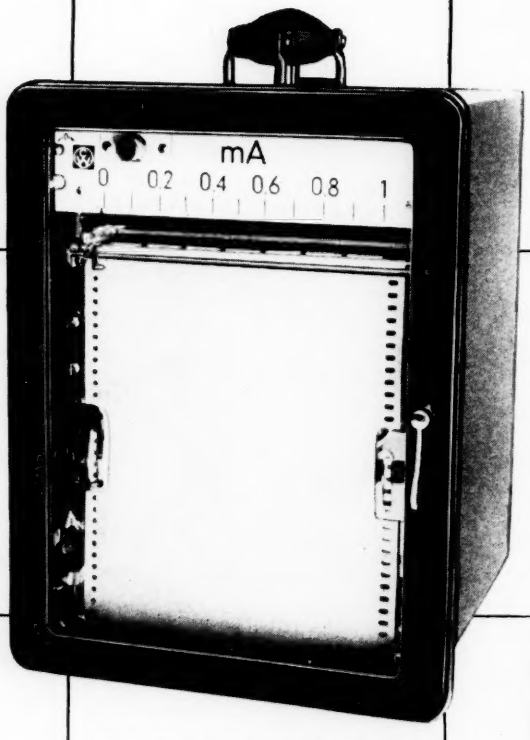
MONROE DATA/LOG

Write to:
MONROE Calculating Machine Company, Inc.
Electronics Components Division
60 Main Street, San Francisco, Calif.

For more information circle **104** on inquiry card.

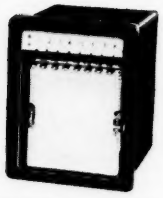


Millivolt Recorder with self-balancing DC amplifier. 2-5-10-20—50-100-200 mv ranges. 1.5% accuracy except 2mv range (2%.)

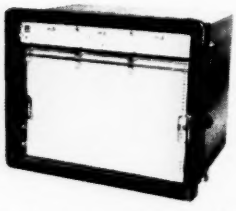


Strip Chart Recorder, standard model 81 (portable) and 82 (flush) are also available for wall and projection mounting. Weighs only 19 lbs. and measures 7½" x 9⅞" x 8½".

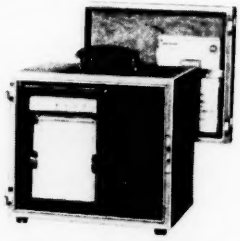
$445.00



Operations Recorders with 4, 8 or 16 pens which register independently the on-off time of machinery. Each track can be a different ink color.



Double size recorder models, take up to six multiple, independent movements. Wall and projection mount available.



Universal AC-DC Recorder with total of 23 ranges. Complete in solid oak case, 13¾" x 11¾" x11" . . . weighs 36 lbs.

Miniature Slim Recorder model saves half the width of standard recorders. Only 3 13/16" x 7½" x 8⅝".

Miniature Square Model Recorder, in flush mount, 5 1/16" square x 13" deep.

Announcing

Curtiss-Wright RECTILINEAR STRIP CHART RECORDERS

Curtiss-Wright recorders, DC preamplifiers, and controllers, can be combined into systems to meet varied demands.

Backed by a leading West German maker's **50 YEARS** of precision instrument manufacturing

A rare combination of precision and ruggedness . . . straightforward in design and simple to operate . . . these new Curtiss-Wright precision instruments are made through a licensing agreement with Metrawatt AG, one of the most experienced of West German precision instrument makers.

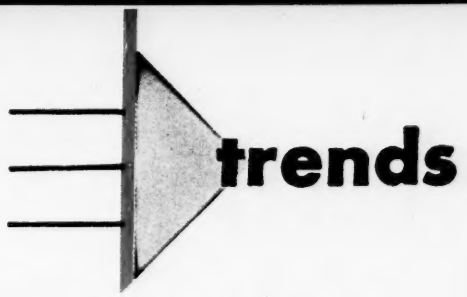
Important features include: *Rectilinear Recording • Inkless and Ink Recording in One Unit • Three-Speed Transmission plus 60:1 Speed Change • 1% Accuracy • Shock, splash and dustproof.* The complete line includes double size and miniature sizes; AC, DC, power and combination movements; wide choice of ranges and chart drives. Write for full information.

ELECTRONICS DIVISION

CURTISS-WRIGHT

CORPORATION • CARLSTADT, N. J.

For more information circle **14** on inquiry card.



Thermistor market is reported by GE to be $3 million in 1958, double its 1956 total. It is expected to be $5 million in 1960; $7.5 million in 1962; $9 million in 1965.

Optical and scientific Instrument analysis by BDSA of Dept. of Commerce, dated March 1958, gives total 1954 sales of optical instruments and apparatus as $250,764,000.

Military electronics market in fiscal 1959 is expected to exceed $4 billion, more than 25% of the $15.8-billion budget of Defense Department. Military electronics market in fiscal 1958 exceeds $3.6 billion; fiscal 1957 market was $3.5 billion.

Engineering research valued at $100 million a year is now in progress on college campuses, reports ASEE. Another $10 million could be accommodated immediately with present staff.

Translation of Russian technical material is increasing. Exclusive worldwide right to translate and publish complete English language editions of 20 Soviet scientific and technical journals has been granted to Consultants Bureau, Inc., under the terms of an agreement between Soviet publications export agency, and the New York publishing firm.

Gross National Product of USA in 1957 was $434.5 billion, says Dept. of Commerce, compared to $426 billion in 1956. Government purchases of services and goods in 1957 was $86.5 billion, including $46 billion on defense.

Burroughs Corporation has installed 245 computer systems, including Datatron's and E101's. It set a new record in December when it shipped nine Datatron electronic data processing systems and other computing equipment, valued at $3,600,000, from its ElectroData Division Plant.

A chemical plant built 20 years ago needed 100 men to operate it and 25 men to repair and maintain it; today a chemical plant which requires 100 men to operate it will require up to 200 men to repair and maintain it.

Most promising unconventional power sources, according to Air Force-sponsored survey of means of converting solar, thermal, chemical and mechanical engeries into electricity are oscillating electromagnetic generator, thermopile generator, ion exchange membrane, fuel cell, and photovoltaic battery.

Easy does it

when you laminate plastic

with the help of

a Fenwal 541 Temperature Indicating Controller

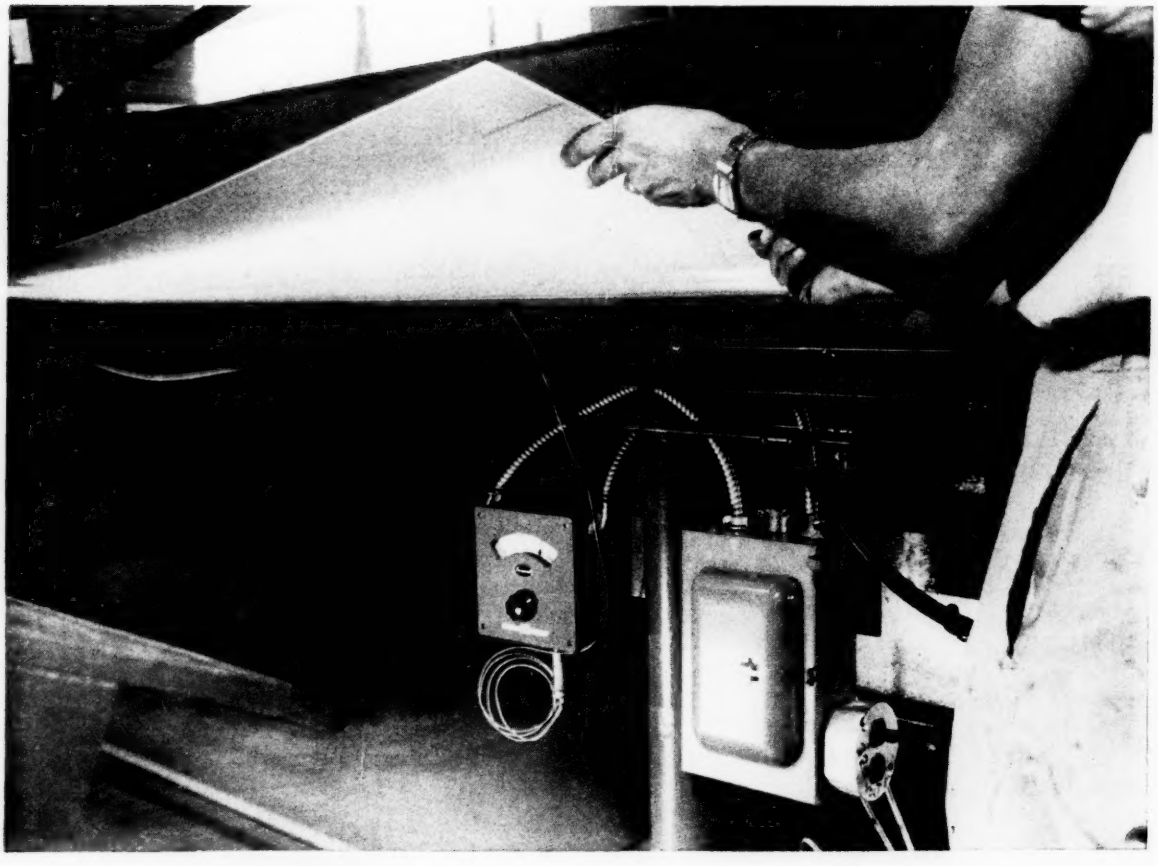
Whether you postform laminated plastic (the machine here is heating a seamless phenolic plastic counter top), or rely on temperature indicating controllers for any of a thousand other reasons, *Fenwal's 541 is the easiest to operate!*

The 541 has a host of long life features — corrosion proof 316 stainless steel, swivel mounted capillaries and bulbs . . . splash and dust proof housing. Self-compensating wear means continued accuracy with minimum maintenance. All components are accessible, easy to adjust. *It's simple and reliable!*

With ranges from −150° to +700°F., the 541 can accurately control one, two, or four circuits. Choose from several bulb and capillary styles, four basic models, variety of housing colors — hundreds of combinations to solve *your* temperature control problem. *It's versatile!*

Find out more about this Fenwal temperature indicating controller that is virtually custom-designed for you. Write to Fenwal Incorporated, 366 Pleasant Street, Ashland, Massachusetts, and ask for a catalog or a sales engineer.

Precise temperature controls on this laminating press make postforming thermoset plastics easy, quick, nearly automatic. This is our single circuit model (there are 575 others) with one SPDT switch and one control pointer. Housings on all Fenwal 541's meet NEMA and JIC specifications.



Fenwal CONTROLS TEMPERATURE . . . PRECISELY

For more information circle **15** on inquiry cards.

HOW ANNIN DOES IT.

The Best Way Yet in Process Control

SPLIT BODY CONSTRUCTION... SINGLE SEAT DESIGN

No other process control valve offers the advantages in economy and adaptability as that provided by the Annin valve. The split body eliminates pockets and shoulders that create undesirable turbulence and accumulated solids, reduces erosion and allows consistent flow behavior with a wide range of fluids under all conditions.

Superior body design permits conversion in any alloy from the basic Globe Body to Corner, Angle or 3-way construction.

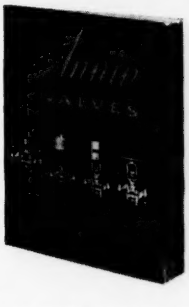
OPERATORS

Three basic Annin operators bring new and improved performance. The DOMOTOR operator is the most responsive, precise positioning and fastest pneumatic operator available... Electro-pneumatic or pneumatic CYLINDER operators, for remote shut-off applications, are designed to withstand continuous "on-off" operations... MANUAL operators, for precise throttling of flow rate and tight closure.

INTERCHANGEABILITY OF COMPONENTS

Applications unlimited are provided by interchangeability of Annin component features. Three types of operators, and five types of packing assemblies (plain extension, bellows seal, doolseal, cooling fin and standard) are interchangeable on one yoke and one body.

SEND FOR THE ANNIN CATALOG—
AN ENCYCLOPEDIA OF VALVE EXPERIENCE AND LEADERSHIP

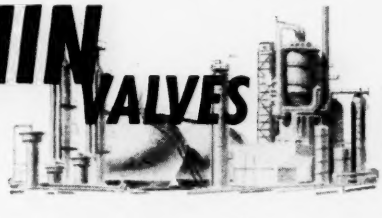


SIMPLICITY IN DESIGN AND MAINTENANCE

The advantages of Annin single seat, split valve bodies, coupled with the design characteristics of Annin Domotor and other operators, provide control engineers with valves that can be installed without compromise in materials, response, tight closure, piping flexibility and dependability... making possible a reduction of parts from 50% to 75%, lower initial cost, lower spare parts inventory, lower maintenance.

THE ANNIN COMPANY
Division of The Annin Corporation
1040 S. Vail Ave., Montebello, California

ANNIN VALVES



For more information circle **16** on inquiry cards.

news

SAMA's Annual Meeting Deliberates on Labor Relations, Marketing Costs, Business Outlook

A. O. Beckman
"Welcome to Calif."

Henry Dever and Tom Allison discuss
"Problems of Diversification"

O. B. Wilson presides

Robert Ohaus

PALM SPRINGS, CALIF.—The Scientific Apparatus Makers Association held its fortieth annual meeting April 20 thru 24. Sunday, April 20, meetings of the executive committees of the various sections composing SAMA took place. Monday some 300 members heard an opening address by *Richard E. Welch*, president of SAMA, and vice-president and treasurer of W. M. Welch Mfg. Co. *Dr. A. O. Beckman*, president of Beckman Instruments, Inc. extended a welcome to California. Then *Charles H. Sevin*, senior consultant, Aldeson & Sessions, spoke on *Increase the Profitability of Sales by Reducing Marketing Costs*," and *O. Glenn Saxon*, professor of economics, Yale University, and economic consultant to Recorder-Controller Section, discussed "*The Business Outlook and How It Will Affect Instrument Companies*."

On Tuesday, April 22, the annual business meeting was held. Mr. Welch was re-elected SAMA president for the coming year. *Aiken W. Fisher*, president, Fisher Scientific Co., and *Edward B. Patterson*, president and treasurer, Arthur Thomas Co., were elected directors-at-large. They succeed *Edw. J. Albert*, president Thwing-Albert Instrument Co., and *E. J. Rhein*, sales manager, scientific division, Kimble Glass Co.

C. S. Redding receives SAMA Award
from SAMA president, R. E. Welch

Wednesday, *Robert D. Gray* director, Industrial Relations Section, California Institute of Technology spoke on "Labor Relations—Where are we Going?" *Henry F. Dever*, president, Minneapolis-Honeywell Regulator Co., and *Thomas Allison*, president, Daystrom-Weston and Daystrom Systems discussed "Problems of Diversification." "Relations Between Distributors and Manufacturers" was the topic of discussion at the concurrent Distributors Session.

At the annual dinner meeting on Wednesday, April 23, *Charles E. Redding*, board chairman, Leeds & Northrup Co., received the coveted SAMA Award which was presented to him by president *Richard E. Welch*.

Great Britain's I.E.A. Exhibition Goes International

LONDON, ENGLAND—Instruments, electronics and automation were the keywords of England's I.E.A. Exhibition held this year (April 16-25) at Olympia, London. Previously held four times (in the odd years since 1951) the bi-yearly event has grown into a yearly "International."

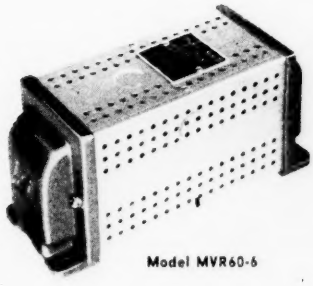
It showed an over-all growth: one-third more space occupied, one-third more British exhibitors, foreign attendance increased 23% over last year's figures (33% against 26%), while over-all attendance increased only 12%—59,601 against 53,034. Visitors from forty countries registered, including a large East European contingent of Russians, Czechs, Yugoslavs, Poles, and many Chinese from the mainland.

The sponsors were six British Trade Associations.

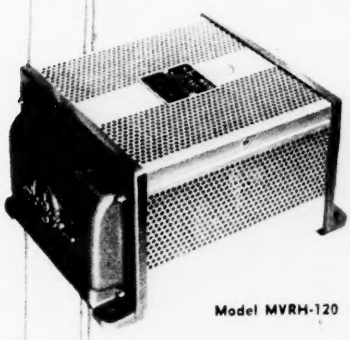
Continued on page 980

now

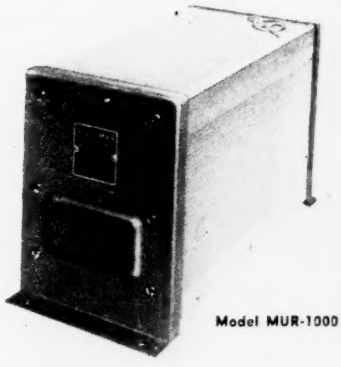
A Complete Line of Magnetic Voltage Regulators



Model MVR60-6



Model MVRH-120



Model MUR-1000

SORENSEN MAGNETIC VOLTAGE REGULATORS

Cover the Full Range—30 to 2000 Volt-Amps...
Better Regulation and Fast Response...Smaller and Lighter

Excellent voltage regulation that's constant within ± 0.5% against any line change from 95 to 130 VAC—with operation that is instantaneous, automatic, continuous, and protected against overload damage—Sorensen MVR's blanket the low and medium power levels.

Supplied in fifteen standard models that range from 30 to 2000 VA rating, these Sorensen regulators can be mounted in any position. Ideal for bench or shop use, or for inclusion as a component in your product lines to improve performance and life.

Model MVR30
Output 30 VA; ± 0.87% regulation from 0 to full load;
Weight: 5 lbs.

Model MVR60-6
Output 60 VA, isolated 6.3 volt output; ± 3% regulation, 0 to full load.

Model MVRH-1000
Output 1000 VA; ± 0.9% regulation, 0 to full load; distortion 3% at any load.

These MVR's are available in three basic designs.

1. Basic Line Regulators, providing minimum-cost, general-purpose, highly reliable regulation of RMS voltage, from 30 to 2000 VA.
2. MVR Filament Regulators, providing regulated and isolated 6.3 volt filament supply for vacuum tubes; outputs from 30 to 500 volt-amps. Also a model with 12.6 filament supply and 60 VA rating.
3. Harmonic Filtered Regulators (MVRH). Lowest distortion of any regulator of similar design. Recommended for critical applications requiring precise waveform.

Complete information on the full line of MVR's is waiting at your Sorensen representative, or will gladly be mailed on your request to:

CONTROLLED POWER FOR RESEARCH AND INDUSTRY

SORENSEN & COMPANY, Inc.
Richards Avenue, South Norwalk, Connecticut

In Europe, contact Sorensen-Ardag, Eichstrasse 29, Zurich, Switzerland, for all products including 50 cycle, 220 volt equipment

For more information circle **17** on inquiry card.

new...improved

IN-LINE
DIGITAL DISPLAY
with One-Plane Presentation

FEATURES

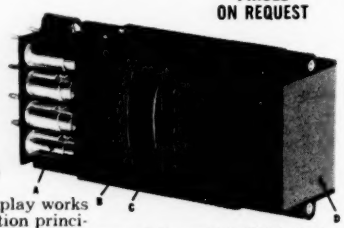
- **Recently developed high-contrast viewing screen for utmost visual sharpness!**
- **Digit style of your choice!**
- **Colored digits of your choice! Suitable to environmental ambient room light.**
- **Digital presentation complementing manufacturer's original equipment!**

Here's a new type of In-Line Digital Display. All numbers and/or characters appear on the front surface of the unit, and are of uniform size and intensity. In addition to being faster and easier to read, the numbers may be quickly seen from any angle of viewing.
The In-Line Display is available as a single unit, or in assembled groups of two, three, four, etc., ready for panel mounting. The viewing screen extends the full width of the individual unit so that final assembly presents a continuous surface for fast, easy reading.

PRICE PER UNIT $15.50

QUANTITY PRICES ON REQUEST

HOW THE IEE IN-LINE DIGITAL DISPLAY OPERATES



The In-Line Display works on a rear-projection principle. When the lamp (A) at rear of the unit is lighted, it projects the corresponding character on the condensing lens (B) through a projection lens (C) onto the viewing screen (D) at the front of the unit.

WRITE TODAY FOR COMPLETE DETAILED SPECIFICATIONS
Representatives in principal cities

INDUSTRIAL ELECTRONIC ENGINEERS
Engineers and Manufacturers of Fully Automatic Systems and Machines
3973 Lankershim Blvd., North Hollywood, Calif.

For more information circle **18** on inquiry card.

Chairman of the Exhibition Committee was Mr. E. W. Semmens, who represented the six Trade Associations.

Instruments Publishing Company was among the exhibitors, and much interest was shown in the pilot issue of *Medical Electronics News*, soon to be added to the three well-established magazines published by the Instruments Publishing Company.

New Computer Center

NEWTON, MASS.—The new GPS Analog Computer Center has opened at the Newton Industrial Center on Route 128 Electronic Highway. Built to house the GPS Instrument Company's expanding Analog Computer Center, the plant is a modern, two story unit which contains 3000 square feet of floor space. Plant equipment includes three complete high-speed analog-computer facilities plus several special purpose computers to determine statistical parameters in terms of its probability distribution, mean and standard deviation.

Fluid Controls Institute Meets

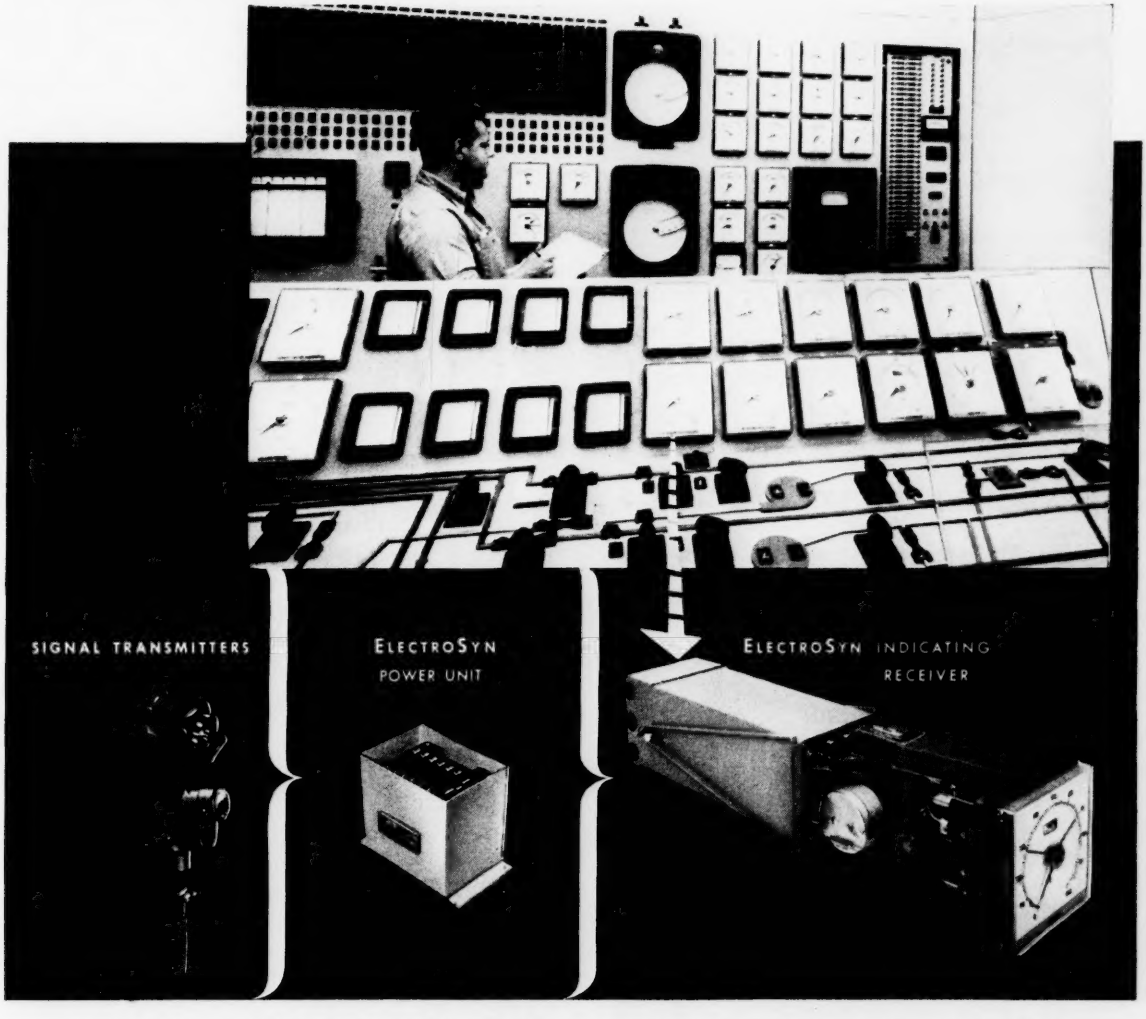
PHILADELPHIA, PA.—The Engineering Standards Committee on Control Valves for Fluid Controls Institute met in Philadelphia on April 1, 1958. The purpose of the meeting was to discuss and revise the "Recommended Voluntary Standards for Measurement Procedure for Determining Control Valve Flow Capacity."

Mr. Al Hanssen of Conoflow Corp. was host to the members of the committee. Shown are (l. to r.) Cecil Johnson of Fisher Governor Co: Bill Rowan of Minneapolis-Honeywell Regulator Co.: Paul Wing of Mason-Neilan: Otto Kniesel of Hammel-Dahl Co.: Donald Lin of Black Sivalls and Bryson: and George Chinn of Kieley and Mueller, who attended the meeting.—

pressure • flow • temperature at Shippingport controlled by

NC CONTROLS

ELECTROSYN SYSTEM



Norwood Controls' ELECTROSYN SYSTEM and other special Norwood instrumentation control the primary reactor plant at Shippingport. ElectroSyn is a reliable, rugged, flexible, completely electro-magnetic null-balance system designed for a wide variety of applications in the atomic, chemical processing and gas and petroleum refining and transmission fields. At PWR it measures, indicates and controls pressure, flow, level, temperature, etc.

Write for ElectroSyn Brochure E 357, Norwood Controls Unit, Detroit Controls Division, 938 Washington St., Norwood, Mass.

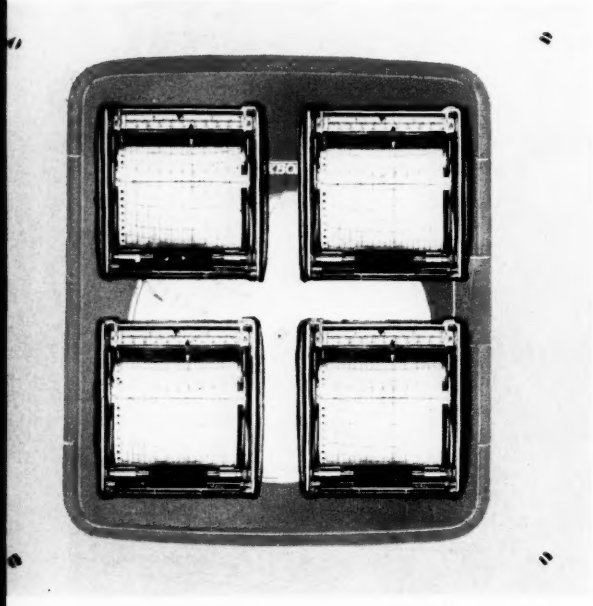
AMERICAN-Standard PRODUCTS

AMERICAN-Standard

DETROIT CONTROLS DIVISION

For more information circle **19** on inquiry card.

CONSOTROL* RECORDING



Four where one used to go — Illustration shows how 4 Consotrol Instruments require less panel space than does a single, conventional 12" recorder.

The ORIGINAL small-case control panel instrument with a FULL SCALE 4 INCH CHART. . .

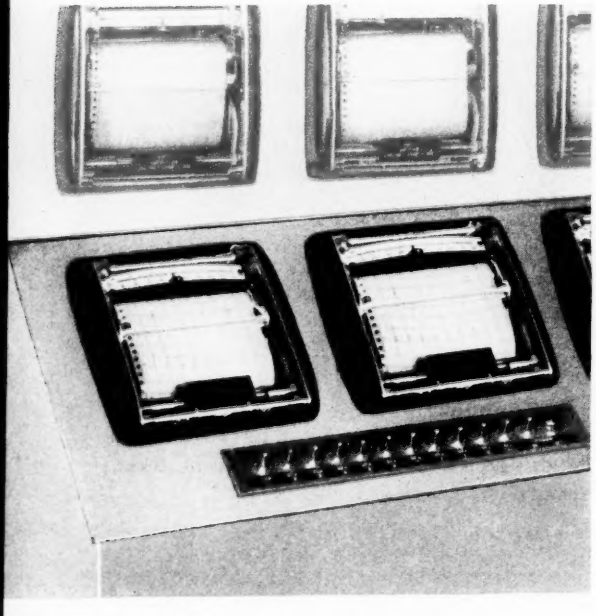
Full-scale *readability!* Here is the industry standard set by Consotrol Instruments, with no compromise in compactness, convenience, or performance.

With the integrally mounted Model 58 Controller, the Foxboro Consotrol Recording Control Station provides precise, dependable control and full-scale records in one-quarter the panel space. A full range of control functions is handled easily with Consotrol Instruments. Auto-Selector control — the control of related variables through a common valve is now possible with Consotrol small-case panel instrumentation, as is centralized control of batch processes.

Maintenance is easier too, with all calibration adjustments made from the front . . . reinking needed only twice a year . . . chart changes as seldom as once a month.

For the complete story, write for Bulletin 13-18. **The Foxboro Company, 466 Norfolk St., Foxboro, Massachusetts, U.S.A.**

INTRODUCED IN 1952 — OVER 35,000 NOW IN USE



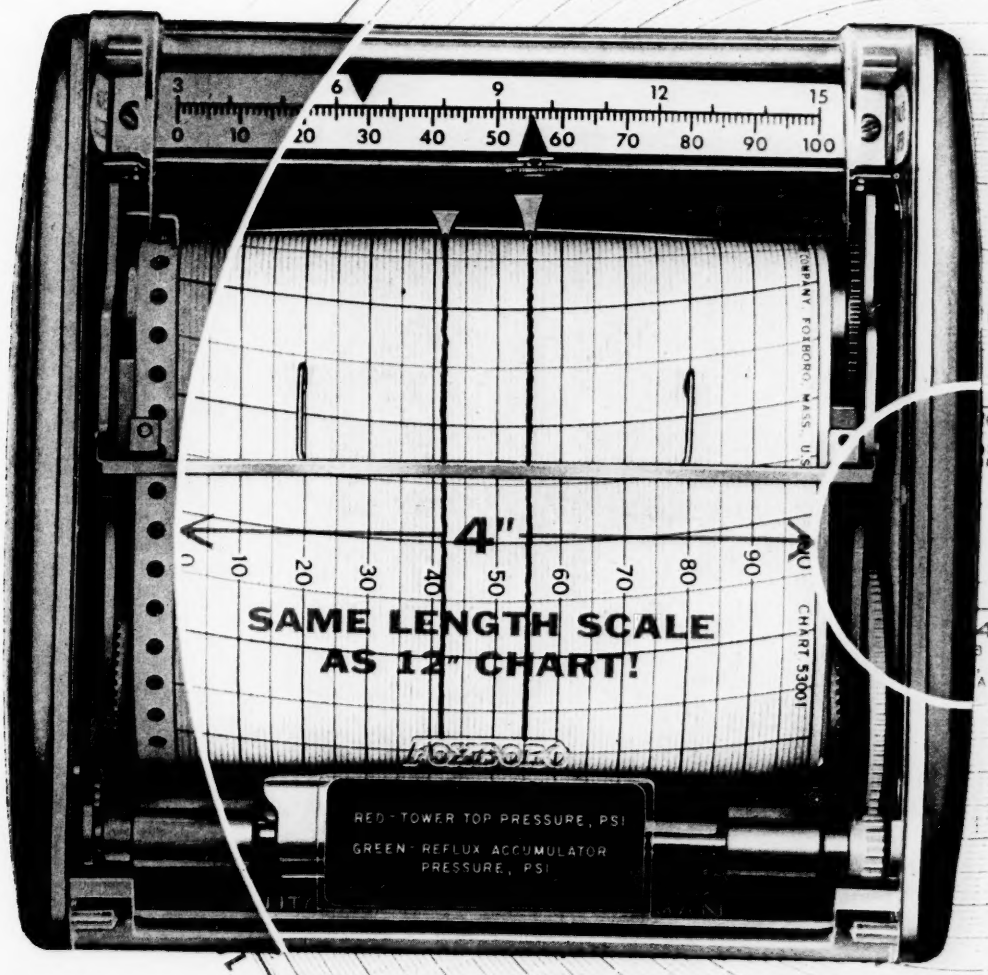
Angle mounting — One- and two-pen Consotrol Recording Control Stations may be panel-mounted as much as 75° from the vertical. A whole "extra" row of instruments can be read without stooping.

*Reg. U.S. Pat. Off.

FOXBORO
REG. U.S. PAT. OFF

For more information circle 20 on inquiry card.

CONTROL STATION



ACTUAL SIZE illustration of Consotrol Instrument super-imposed on standard 12-inch chart. Note full 4" wide strip chart has same length scale as 12" circular chart.

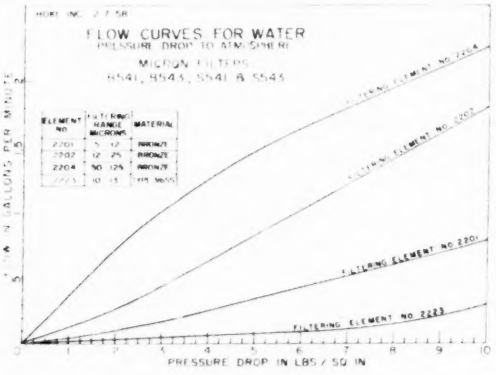
CONSOTROL INSTRUMENTS

RECORDING · CONTROLLING · INDICATING

briefs

Fluid Filtration

Usually, a micron is the unit used to describe the degree of filtration. A micron is a millionth of a meter, or a little less than "half a tenth" of a thousandth of an inch . . . The flow that a clean filter unit will han-

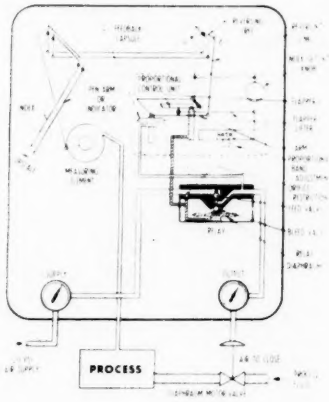

FLOW CURVES FOR WATER
PRESSURE DROP TO ATMOSPHERE
MICRON FILTERS
5541, 5543, 5541 & 5543
FILTERING ELEMENT NO 2204
FILTERING ELEMENT NO 2202
FILTERING ELEMENT NO 2201
FILTERING ELEMENT NO 2223
PRESSURE DROP IN LBS / SQ IN

dle can be calculated in terms of the fluid's viscosity and the allowable pressure drop through the filter . . . From a practical point of view, a filter should be big enough to pass the flow required at a pressure drop which can be tolerated by the system . . . (*From new 4-page "Flow Sheet" Vol. 3, No. 1, Hoke Inc., 8. Dean St., Englewood, N. J.*)

For this literature circle **201** on inquiry card.

Proportional Control

Process pressure actuates measuring element which operates indicator and reversing tree. Assume an increase in pressure. Indicator moves upscale clockwise and reversing tree moves clockwise, causing flapper to approach nozzle. Supply air bleeds through restriction and as nozzle is slightly closed, relay diaphragm ex-



pands closing relay bleed valve and opening feed valve. This increases output pressure which shuts diaphragm valve somewhat and expands feed-back capsule. Expansion tends to re-open nozzle by lifting flapper until balance is achieved. When knife edges are at extreme left, feed-back is at its maximum and resulting band is 100% . . . (*From 20-page Catalog 456 A, United States Gauge, Div. of American Machine and Metals, Inc., Sellersville, Penna.*)

For this literature circle **203** on inquiry card.

Electronic Recorder

The recorder is actuated from an input box which contains the appropriate input components for the individual measurement. This supplies a drive signal to an ac amplifier. The amplifier causes a reversible motor (shaded pole type) and feedback potentiometer to move to the precise output shaft position required to balance the circuit. The reversible motor also drives the recording pen arm linkage, thus securing a pen position proportional to the input quantity . . . A transistor chopper is employed on dc applications. . . . A prime application of the recorder is to ac or dc signal transmission. Where distances do not exceed 20 ohms total line resistance (about 2000 feet), simple ac three-wire transmission is employed. For greater transmission distances the electronic recorder is used as a DC potentiometer.

Resolution—0.15% of full scale: Repeatability—0.25% full scale: Overall Accuracy—0.5% full scale: Chart—12" diameter: Pen Travel Time—2 seconds full scale (0.5 sec inch) (*From new 4-page Bulletin MSP-149, Hagan Chemicals & Controls, Inc., Hagan Bldg., Pittsburgh 30, Pa.*)

For this literature circle **202** on inquiry card.

Micro Optical Pyrometer

The New Pyro Micro-Optical Pyrometer . . . is capable of measuring temperatures of targets smaller than 0.001" in diameter, and can be adjusted for focal distances varying from 5 inches to infinity . . . The wide scale direct-reading meter is of the suppressed

zero type permitting full use of the entire scale length, and it is an easy matter to reproduce temperatures in the order of two to three degrees Centigrade . . . three wide overlapping scale ranges from 700°C to 3200°C (1300°F to 5800°F) cover almost every conceivable temperature measurement problem . . . (*From new 4-page Catalog 95, T. . Pyrometer Instrument Co., Inc., Bergenfield, N. J.*)

For this literature circle **204** on inquiry card.

UNAMBIGUOUS STRAIGHT BINARY OUTPUT
new!
capacity: 10 DIGITS.
resolution per input shaft revolution:
1024 COUNTS (10 BINARY DIGITS)
accuracy:
1 COUNT IN TOTAL CAPACITY.
10 BIT ENCODER
128 COUNTS (7 BINARY DIGITS)
ONE COUNT IN TOTAL CAPACITY.
7 DIGITS—1 PART IN 128. 13 DIGITS—1 PART IN 8192. 17 DIGITS—1 PART IN 131,072. 19 DIGITS—1 PART IN 524,288.
0-2000, 0-3600, 0-20,000, 0-36,000, 0-360,000 COUNTS.
1 COUNT IN TOTAL CAPACITY.
new!
MODEL: 758.
resolution per input shaft revolution:
Shaft and Servo driven hermetically sealed units available.
accuracy:
SINE COSINE

LIBRASCOPE

VERSATILITY IN DESIGN
FLEXIBILITY IN APPLICATION

packaged shaft-to-digital encoders

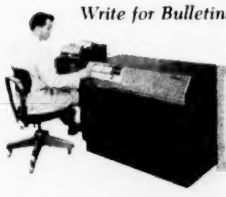
The Librascope Shaft Position-to-Digital Encoders is the most convenient and accurate device for the conversion of analog shaft position into digital form. Added to the series of Librascope encoders, which include the Binary and Binary Coded Decimal, are the *new* 10-bit, 1024 count and Sine Cosine units. The 10-bit encoder provides parallel, unambiguous, straight binary representation of shaft position, and the Sine Cosine encoder is used where the natural functions of the sine and cosine are required with precision.

Features of Librascope encoders are: long life, high accuracy, double brush pickoff systems, serial and parallel readout into single or multiple scan matrices, solid state or vacuum tube, synchro-mounted, and time sharing (through the use of isolation diodes).

Associated circuitry can be designed to fit your data handling problem.

Write for Bulletins L10-1 and D-E10A for complete information.

Librascope's use of the LGP-30 computer simplifies complex design and production problems, and assures computer-engineered quality in meeting design and delivery schedules.



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LIBRASCOPE INCORPORATED • 808 WESTERN AVENUE • GLENDALE, CALIFORNIA

For more information circle **21** on inquiry card.

Here's a thermocouple for hard-to-make measurements

BRISTOL "Armorox" thermocouple, here about to be installed in tunnel kiln truck, is more flexible and smaller, but more rugged, than conventional thermocouples.

The Bristol "Armorox" thermocouple now makes difficult temperature measurements easy.

Good for temperatures up to 2000°F. and at pressures to 50,000 psi, the "Armorox" thermocouple is metal-sheathed, ceramic-insulated and *flexible*—easily bent around twice its own diameter to get into out-of-the-way places. What's more, no additional protecting tube is required.

The entire line of Bristol pencil-type thermocouples is offered in "Armorox" metal-sheathed ceramic-insulated construction as well as conventional construction. *Metal-sheathed construction plus tightly packed refractory insulation now permits use of smaller gauge wire than ever before at higher temperatures.* Wire sizes as small as #30 AWG give outstanding service in the advanced construction.

Sheathing available in stainless steel and Inconel*—other metals available for special applications. Diameters from 1/16 to 1/4 inch. Lengths up to 30 ft. Thermocouples available in Chromel-Alumel†, iron-constantan, copper-constantan, and other materials. Can be used for every application of conventional pencil-type thermocouples. Meet the ISA standards for accuracy.

Write for complete data on this Bristol development in pyrometry. The Bristol Company, 154 Bristol Road, Waterbury 20, Conn. B.15

*T. M. Reg. by International Nickel Co.
†T. M. Reg. by Hoskins Manufacturing Co.

BRISTOL *TRAIL-BLAZERS IN PROCESS AUTOMATION*

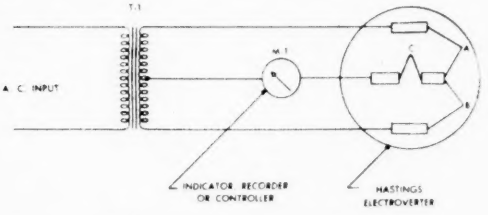
AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **22** on inquiry card.

BRIEFS —CONTINUED

Hastings Electroverter

The Hasting Electroverters consist of three or more fine thermocouples of noble metals arranged such that the a-c current flow directly heats two or more thermocouples from which a d-c output voltage is generated . . . The . . . thermopile . . . becomes part of the bridge circuit. The thermocouples in the a-c circuit are heated by the alternating current. Any change in temperature affects the d-c output of the thermocouples. An additional thermocouple is included in the d-c



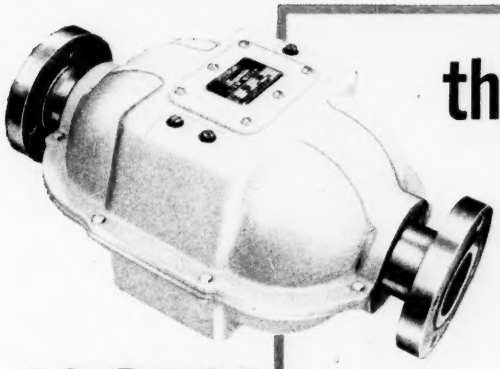
meter circuit. This couple is unheated and is the same size as those in the a-c circuit. A sudden or momentary change in ambient temperature develops thermoelectric voltages in all the thermocouples, but the transient effects in heated and unheated elements are arranged to be equal and opposite, so the unheated couple compensates for these transient effects of change in the ambient temperature . . . The Hastings Electroverter furnishes a d-c voltage which is a measure of the a-c current, voltage, or power, depending on the circuit design . . . Characteristics: Dimensions: $\frac{1}{2}$" diameter; $\frac{3}{4}$" over-all length; Resistance: 9 ohms; Time Constant: 50 millisec . . . (*From new 2-page Catalog Sheet* 154, *Hastings-Raydist, Inc., Hampton, Virginia*)

For this literature circle **205** on inquiry card.

Data-Blocs and Data-Pacs

Two electrically compatible but physically different forms of logic can be used for rapidly determining the feasibility of a logical arrangement. Such things as special pulse generators, pulse distributors, arithmetic units, memory access circuits, input-output registers, high-speed shift registers, counters, scalers, digital display circuitry, and many other devices can be rapidly assembled and checked out in a matter of minutes . . . Data-Blocs (5-Mc and higher circuitry) can be also used for setting up special test equipment or circuitry to check out other devices or systems. It is possible to build a complete computer or large scale digital system with these units and have it operate continuously at high speed in a completely reliable manner . . . Data-Pacs are electrically equivalent to the Data Blocs previously described. They are primarily intended for permanent equipment use where convenience in logic plugability is not of prime importance . . . (*From new 8-page Bulletin "Data Bloc and Data Pac System," Harvey-Wells Electronics, Inc., Res. and Devel. Div., 5168 Washington St., West Roxbury 32, Mass.*)

For this literature circle **206** on inquiry card.



the meter with NO flow restrictions

now handling all these difficult liquids

Foxboro's first Magnetic Flow Meter went "on stream" in 1954. Today, this new-type meter has gained industry-wide application for precise, continuous measurement of difficult process liquids.

The Magnetic Flow Meter is installed as simply as a length of pipe. No seals, purges, meter runs, or straightening vanes are required. It connects by standard electric cable to remote Dynalog Electronic Recorder. Over-all accuracy of the system is ±1%. And the meter even measures reversing flows.

With easy-to-measure liquids, or with tough ones like those listed below, the performance-proved Foxboro Magnetic Flow Meter provides flow measurement with no line restrictions. For complete details, write today for Bulletin 20-14B. **The Foxboro Company, 466 Neponset Ave., Foxboro, Mass.**

CHEMICALS
ammonium nitrate solution
phosphate slurry
rayon viscose
magnesium carbonate slurry
phosphoric acid slurry
detergent concentrate
rosin size
starch solution
rubber copolymer
liquid latex
soda ash
sulphuric acid
70% sodium hydroxide
soap flow
styrol
magnesium hydrate

FOOD
beer
grape juice
apple juice
pineapple juice
tomato juice
milk
starch slurry
sugar syrup
coffee slurry
molasses

PULP AND PAPER
all types of pulp stock
cooking liquors
spent liquors
bleaching chemicals
lime mud slurries
sizes
alum
dyes

WATER AND WASTES
activated sludge
fresh water
raw sewage
digested sludge
primary sludge
return activated sludge

METALS AND MINING
pickling acid
sand slurry
ferrous chloride
limestone shale slurry
bauxite slurry
gilsonite slurry
aluminate liquor
uranium ore slurry
thickener mud
cement slurry
flue dust slurry
acid wastes

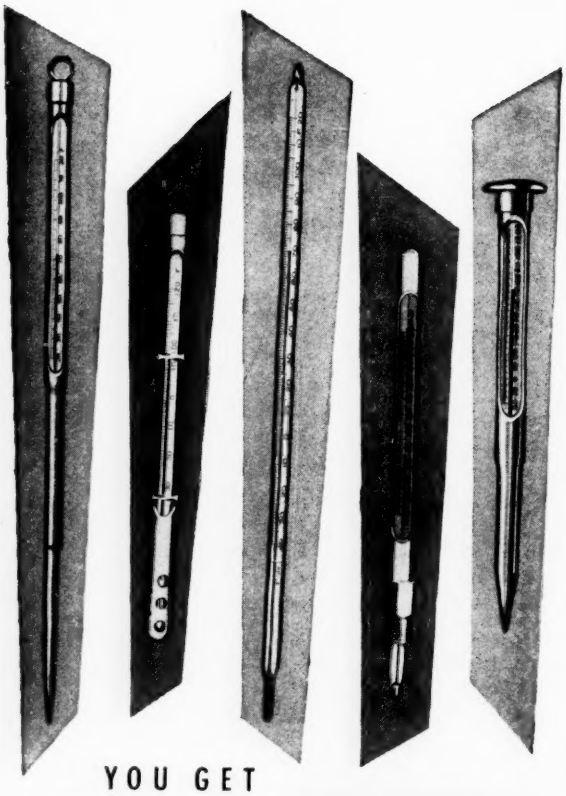
OIL INDUSTRIES
drilling mud
phosphoric acid
ethenol extract
scrubber recycle water
urea solution
nitrate solution
spent acid
sodium silicate & water
sodium chloride brine
tar-sand slurry

METER SIZES RANGE FROM 3/16 INCH TO OVER 6 FEET PIPE DIAMETER

FOXBORO
REG. U.S. PAT. OFF.

MAGNETIC FLOW METERS

For more information circle **23** on inquiry card.



YOU GET

dependability PLUS

WITH MOELLER TEST THERMOMETERS

because our business is the
design and manufacture of temperature measuring
instruments—and has been since 1867.
Moeller Test Thermometers are guaranteed for permanent
accuracy and are made according to specifications
set forth by the United States Government,
A.S.T.M., and other Societies and Associations.
Mail the coupon today for descriptive
literature on Moeller Test Thermometers.

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Representatives in Principal Cities

Gentlemen: Without obligation, please send me Catalog No. 800 on Moeller Test Thermometers, Hydrometers, Temperature and Hydrometer Conversion Tables.

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FIRM .....
ADDRESS .....
CITY ..... ZONE ..... STATE .....

For more information circle **24** on inquiry card.

Nozzle Safety-Relief Valves

1. Constant Back Pressure

BalanSeal valves are sometimes specified for constant back pressure where corrosion protection is desired. Capacity corrections are the same as for variable back pressure. BalanSeal valves are generally specified for variable back pressure conditions. . .

Sizing Factors For common vapors and gases

Gas or Vapor	Molecular Weight	K_m ($\sqrt{M}$) Factor	k (cp/cv) at 60°F	C (Constant)	K_c (C/315) Factor
Air	28.970	5.382	1.410	356	1.130
Acetylene	26.040	5.103	1.260	343	1.089
Ammonia	17.030	4.126	1.310	348	1.105
Argon	39.944	6.320	1.668	377.8	1.200
Benzene	78.110	8.838	1.118	328.8	1.044
N-Butane	58.120	7.630	1.094	326.4	1.036
Iso-Butane	58.120	7.630	1.097	326.7	1.037

2. Variable Back Pressure

(a) Vapor, gas, air, and steam capacities are multiplied by factor K_v, entering the curve with the P% back pressure computed from the maximum back pressure, psia. (b) Liquid capacities are first computed as for constant back pressure, using "set pressure minus maximum back pressure" under the radical. Capacity tables can also be used for this step, entering table with pressure differential. Next, multiply by factor K_w from curve . . . (*From new 16-page Catalog FE-118, Farris Engineering Corp., 100 Commercial Ave., Palisades Park, N. J.*)

For this literature circle **207** on inquiry card.

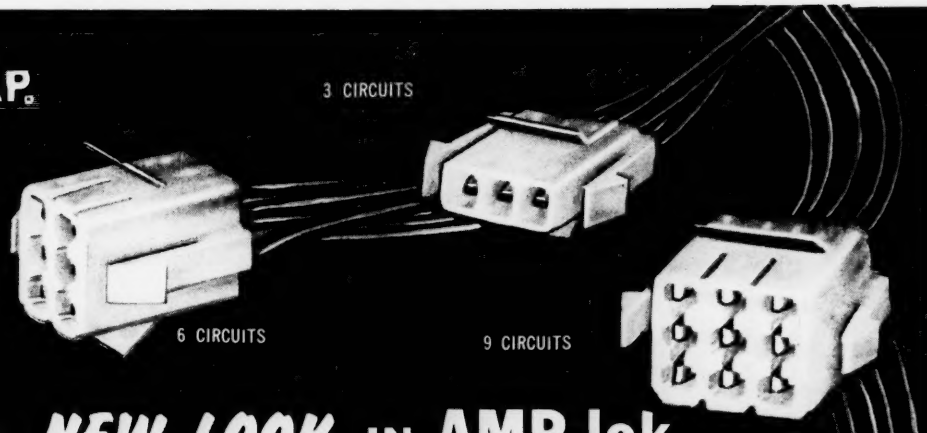
Wire Thermocouples

"Ceramo" (is used) for extended life at high temperatures, or for subzero temperature applications where condensation is a problem. "Ceramo" has excellent resistance to moisture, petroleum products, chemical action, and abrasion. It can be bent on an extremely small radius without shorting or grounding: can withstand extremely high pressures and, for many applications, may be used without outer protection tubes. Response time of $\frac{1}{8}$" O.D. "Ceramo" is comparable to 14-gage, wire-type thermocouples, and will considerably outlast wire-type thermocouple construction. $\frac{1}{8}$" O.D. supplied with transition piece at reference end of thermocouple to accommodate 16-gage wire for termination. Standard sheath material is Inconel. Wide choice of other sizes, calibrations, and sheath materials . . . (*From new 12-page Catalog Section E, Thermo Electric Co., Inc., Saddle Brook, N. J.*)

Thermocouple Materials	Temperature Range	Limits of Error Standard	Special
Copper-Constantan	—300°F. to —75°F.	±2%	±1%
	—150°F. to —75°F.	±2%	±1%
	—75°F. to +200°F.	±1½°F.	±¾°F.
	200°F. to 700°F.	±¾%	±⅜%
Iron-Constantan	0°F. to 530°F.	±4°F.	±2°F.
	530°F. to 1400°F.	±¾%	±⅜%
Chromel-Alumel	0°F. to 530°F.	±4°F.	±2°F.
	530°F. to 2300°F.	±¾%	±⅜%

For this literature circle **208** on inquiry card.

AMP

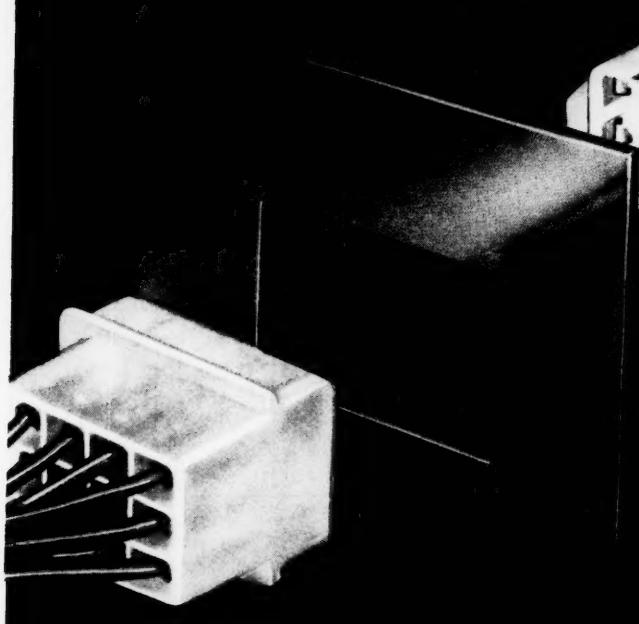


THE *NEW LOOK* IN AMP-lok

Now . . . connect 3, 6, 9 or 12 circuits simultaneously with the AMP-lok multiple connector and a simple push of the fingers.

All units are self-anchoring and require no supplementary mounting parts in through panel multiple connector applications.

AMP-lok can be used as a safe, free-hanging multiple connector also.



AMP-lok obsoletes all it replaces because of the following design features:

- contacts are identical . . . self cleaning . . . recessed for safety
- finger grip engagement and disengagement
- polarized to eliminate circuit error
- wide panel thickness accommodation—one simple mounting hole required
- color coding available

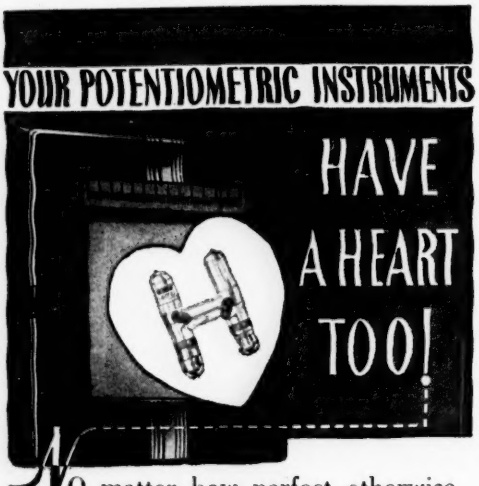
Additional literature and samples available on request.

AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

A-MP products and engineering assistance are available through wholly owned subsidiaries in: Canada • England • France • Holland • Japan

For more information circle **25** on inquiry card.



NO matter how perfect otherwise, the human organism isn't much good without a dependable heart. The same is true of your automatic temperature and pH control instruments.

The "heart" of most such instruments for the past quarter century has been the Eplab Standard Cell. It is a "yardstick" for translation of voltage to temperature or pH. The first American commercial cell of its type, constantly improved by research, it is "as standard as sterling".

Get ACCURATE temperature or pH control with potentiometers and make sure the standard cells are EPLAB.

The Eppley Laboratory, Inc. 2 Sheffield Ave., Newport, R. I.

EPLAB *Standard* CELLS
FOR POTENTIOMETRIC INSTRUMENTS
As Standard as Sterling

For more information circle **26** on industry card.

BRIEFS —CONTINUED

ALNICO 5Cb

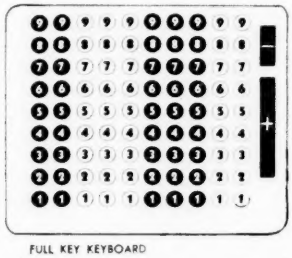
ALNICO 5Cb is an oriented alloy. That is, it is so heat-treated that its magnetic properties are very *much better in one direction than in any other.* Direction of desired magnetization must therefore be specified in ordering magnets made of this material. This grade has the highest energy product of any known alloy. Nominal composition is 8% aluminum, 14% nickel, 24% cobalt, 3% copper, 0.1% columbium and the balance iron . . . (*From new 20-page Bulletin 158, Thomas & Skinner, Inc., 1120 East 23rd St., Indianapolis 7, Ind.*)

Magnet Material	H max Oersteds	B max Gausses	Residual B	Coercive Force	External Energy BdHd max
Alnico 1	2000	12350	6800	520	1,350,000
Alnico 2	2000	12600	7300	640	1,750,000
Alnico 3	2000	12000	6700	480	1,300,000
Alnico 4	3000	11850	5700	720	1,400,000
Alnico 5Cb	3000	16300	12800	660	5,700,000
Alnico 5E	3000	15000	11100	730	4,200,000
Alnico 5	3000	16000	13000	790	3,800,000
Alnico 7	3000	12000	5700	970	1,600,000

For this literature circle **209** on industry card.

Digital Printers

Digit-matic can be used with paper tape punches and readers, punched tape typewriters, electronic counters, digital testing equipment, analog to digital devices, time interval meters, pulse height analyzers, digital scales, production counters, and for such Integrated Data Processing office applications as automatic invoice calculating, purchase order extensions,



FULL KEY KEYBOARD

account selection and totaling . . . The characteristics of the electrical devices which furnish the digital input to the Digit-matics—the number of columns, speed of operation, numerical coding, parallel or serial output, etc., are factors which point to the selection of either a parallel or serial Digit-matic . . .

Parallel entry machines are equipped with 3 to 10 columns of solenoids . . . The solenoids operate between 125 to 160 volts DC. This voltage range was selected because it's easily obtained directly from the 115 volt AC 60 cps lines by means of a full wave bridge rectifier . . . the speed with which the solenoids respond is dependent upon the voltage applied to them . . . (*From new 12-page Form 671-71-2, Electronic Sales Div., Victor Adding Machine Co., 3900 Rockwell St., Chicago 18, Ill.*)

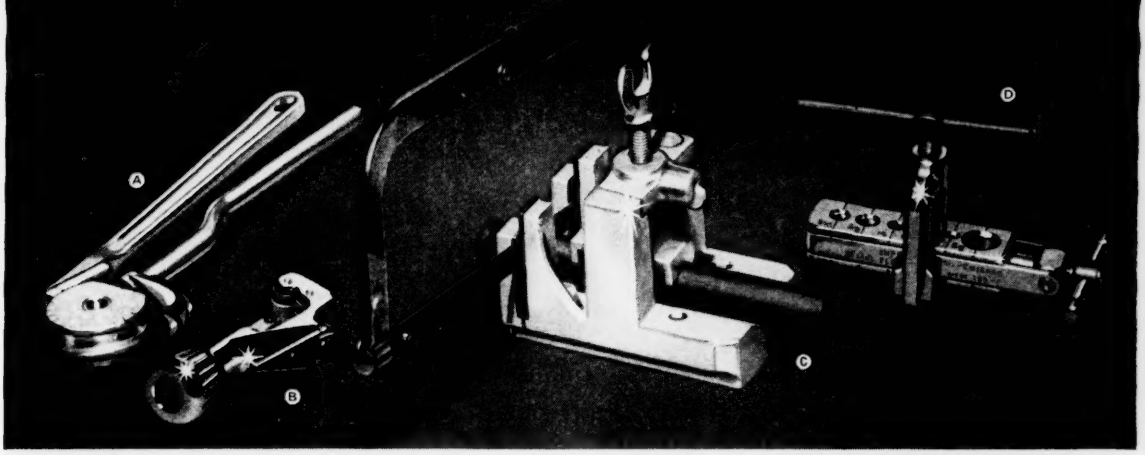
For this literature circle **210** on industry card.

NEW TOOL DEVELOPMENTS BY IMPERIAL

BY-PASS OLD METHODS OF CUTTING, BENDING, AND FLARING TUBING

ALSO CUTTING WIRE BRAID HOSE.

URGE IMMEDIATE INVESTIGATION



Ⓐ **Bends hard or soft tubing.** Open side design. Forms neat, accurate bends, any angle up to 180°. Calibrated. Specify No. 364-FH "Blue Dot" bender. Sizes: ⅛ to ⅞" O.D. tubing. Individual benders for each size.

Ⓑ **Spare cutting wheel now included at no extra cost with this tube cutter!** Fits behind retractable reamer. Instantly available. Cutter has free-wheeling, ball-bearing action. No. 274-FA Hi-Duty tube cutter for ⅛ to 1⅛" O.D. tubing.

Ⓒ **For sawing wire-braid pressure hose or metal tubing.** Assures square, clean cuts. Minimum wear on hacksaw blade due to special gripper. Extra-tight slide-to-size clamping. For ⅜ to 1½" O.D. hose or tubing. No. 384-F bolts to bench or clamps in a vise.

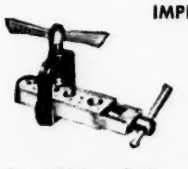
Ⓓ **Industrial hard chrome cones now furnished on Imperial flaring tools.** No extra cost! Smoother flares, up to 55% easier! Types for 45°, 37° and double flares. No. 300-F for 45° flares. No. 437-F for 37° flares. Sizes: 3/16, ¼, 5/16, ⅜, ½ and ⅝" O.D. tubing.

Imperial offers you industry's most complete line of tube working tools with more work-saving features!

If it's new . . . it's from Imperial! The complete tubing tool line with more "firsts" to its credit continues to take the "work" out of tube working with *more* new developments!

That means no matter what the tubing . . . copper, aluminum, steel or stainless steel . . . or the type of job, you're adding greater accuracy, speed, ease and better craftsmanship to cut costs right down the line. *Tool up with Imperial and be first with the latest!*

Avoid lost time and grief by replacing labor-wasting tools NOW with years-ahead IMPERIAL tubing tools. See your Imperial distributor now, or write for Catalog 3088.



No. 500-F and No. 507-F Rol-Air flaring tools for 45° and 37° flares.

No. 140-F Test plug — for closing end of tube temporarily. Pressures to 100 lbs.

No. 206-F — Adjust-o-matic, slide-to-size tube cutter. For ¾" to 2¼" O.D. Tubing.

No. 400-F flares stainless steel, titanium — other metal tubing to AN standards.

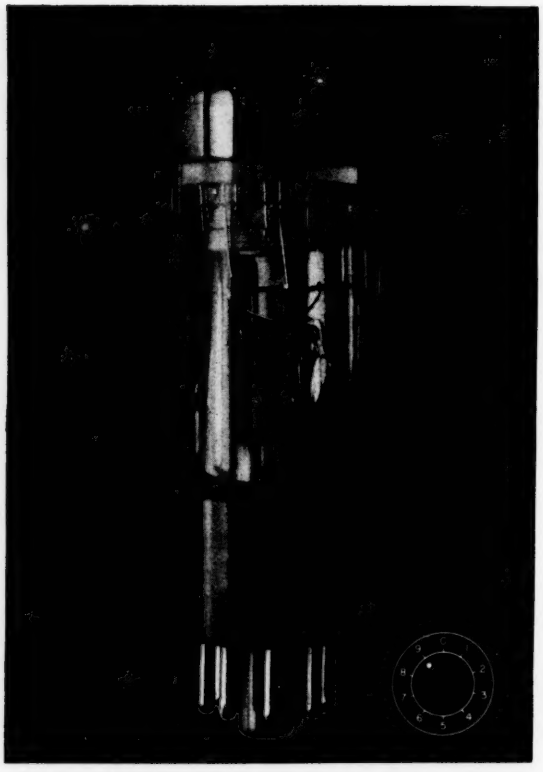
No. 270-F Gear type bender bends any type of tubing.

No. 260-FH tube bender combination—hard or soft tubing, 7 sizes: ¼ to ⅞" O.D.

THE IMPERIAL BRASS MFG. CO.
6300 W. Howard St., Chicago 31, Ill.
Dept. IA68
In Canada: 18 Hook St., Toronto, Ontario

IMPERIAL — *Emblem of Quality*

For more information circle **27** on inquiry card.



Need a **PROVEN** tube that indicates and counts?

dekatron*

The only cold-cathode glow transfer counting tube **WITH OVER 10 YEARS OF SERVICE RELIABILITY AND PERFORMANCE.** Simple circuitry. Electronic speed and accuracy up to 20,000 counts/sec. For counting, sorting, programming, unit flow, packaging and many other applications. Continuous visual reference to total count. For detailed information, request Technical Data Sheet IC4001.

*Trademark

Baird Atomic

Baird-Atomic, Inc.

33 UNIVERSITY RD., CAMBRIDGE 38, MASS.

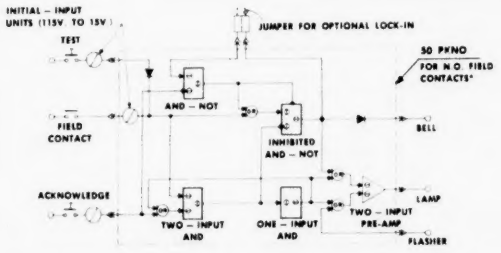
Instrumentation for Better Analysis

For more information circle **28** on inquiry card.

BRIEFS—CONTINUED

Static-Magnetic Annunciators

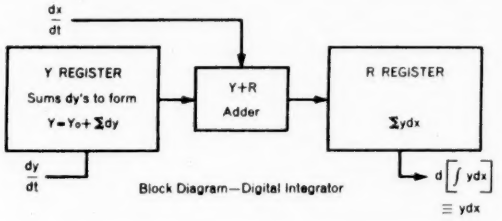
The design of Panalarm's static-magnetic elements is based on magnetic amplifier principles. These control elements are replacements for electro-mechanical relays. The replacement is not on a one-for-one basis. Relays accept one isolated input, and provide a number of isolated outputs. Static-magnetic controls accept several inputs and supply a single output, which may be used for a number of functions. These features of static-magnetic controls makes them a natural choice for performing basic logic functions with a very high degree of reliability . . . (*From new 4-page Bulletin* 101, *Panellit, Inc.*, 7401 *N. Hamlin Ave., Skokie, Ill.*)



For this literature circle **211** on inquiry card.

Digital Differential Analyzers

The basic component in any differential analyzer is the integrator . . . In the Litton Model 20 there is no physical collection of components called integrator. An integrator exists as magnetizable cells on the surface of a magnetic drum processed according to a rule of numerical integration. These integrators are capable of interconnection and intercommunication in the same sense as mechanical or electronic integrators with the variables being represented by repetition rates of digital pulses . . . the design of the computing logical networks is such that trapezoidal integration is achieved. Accuracy of integration is adequate for the widest variety of input functions . . . (*From new 4-page bulletin "Digital Differential Analyzers," Litton Industries, Electronic Equipments Div., 336 N. Foothill Rd., Beverly Hills, Calif.*)



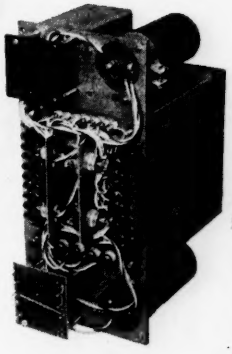
Block Diagram—Digital Integrator

For this literature circle **212** on inquiry card.

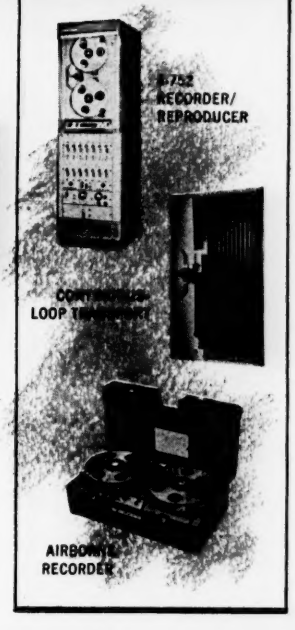
CEC announces the new digital magnetic tape recorder/reproducer

- *all transistorized electronics*
- *modular construction**
- *starts and stops in less than 5 milliseconds*
- *high-speed servo response*
- *continuous-duty servo motors*
- *all-metal-surface magnetic heads*
  (.5" SPACING BETWEEN READ AND WRITE HEADS)
- *uses ½" to 1¼" tape*
- *10½" reels with NARTB hubs*
- *designed for standard rack mounting*
- *size: 19" wide by 24½" high by 13" deep*

NOW AVAILABLE... Not merely a laboratory instrument, but a fully ruggedized, reliable digital recorder designed for a whole gamut of industrial applications where long periods of unattended operation with minimum maintenance and down-time are paramount. Standardized speeds, track-width and spacing, and start and stop distances assure complete compatibility with other digital tape transports and handlers. *Contact your nearby CEC field office for complete information,* or write for Bulletin CEC 1608-X9.



**Modularized components, such as Power Supply Unit at right, permit instant access and easy maintenance or replacement with minimum down-time.*



DataTape Division

Consolidated Electrodynamics

300 North Sierra Madre Villa, Pasadena, California

OFFICES IN PRINCIPAL CITIES THROUGHOUT THE WORLD

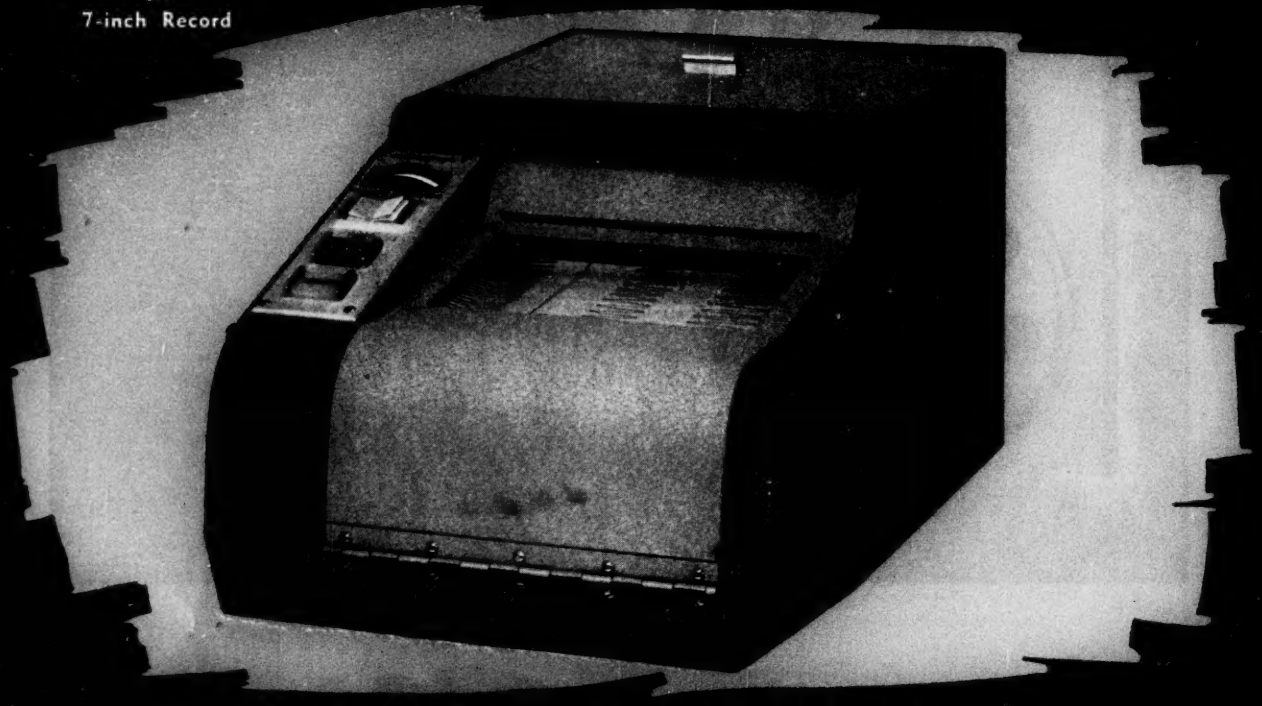
For more information circle **29** on inquiry card.

TOP PRIORITY PREFERENCE

D/R DIRECT RECORDING
DIRECT READOUT

MODEL 616 OSCILLOGRAPH

25 Traces
on
7-inch Record



ACCURATE • TIME SAVING • VERSATILE

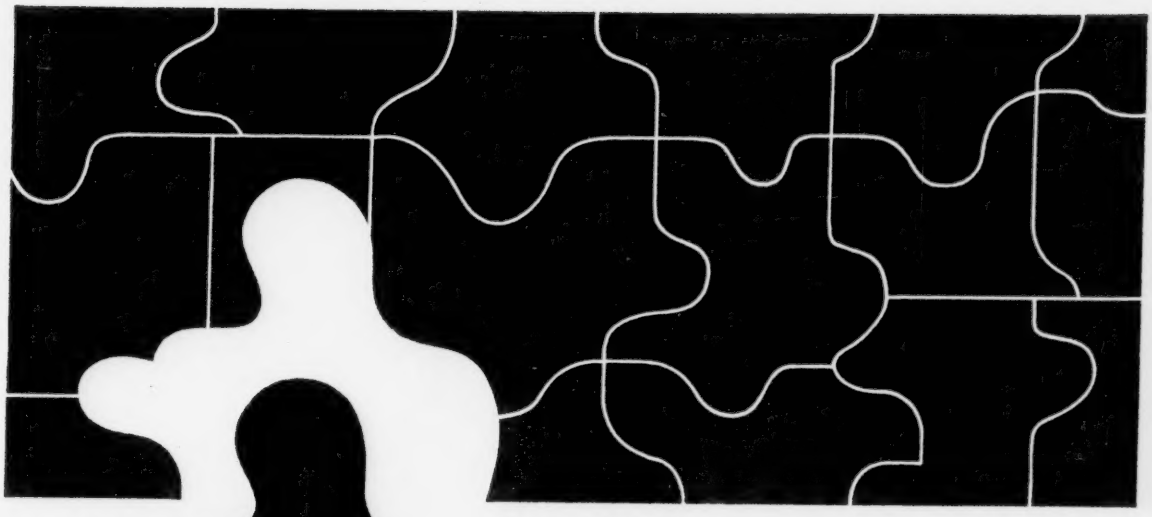
Twenty-five channels of direct recording are offered by this versatile Midwestern D/R 616 Oscillograph. Photographic records of the galvanometer traces appear rapidly on the seven-inch paper which requires no chemical development.

Advanced design of the D/R 616 permits the record to be ejected continuously for immediate handling, or for visual inspection plus automatic roll-up and storage of the record at the discretion of the operator.

Standard Midwestern Galvanometers are used.

If you have a problem involving data recording under normal or extreme conditions — one of the many specialized models of Midwestern Instruments' oscillographs will be your solution — Call, wire or write . . .

MI MIDWESTERN INSTRUMENTS 4151 AND SHERIDAN / TULSA, OKLAHOMA



Puzzled by ground loop problems? How to rescue microvolt signals from volts of noise?

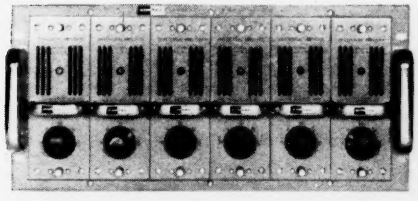
HERE'S WHY KIN TEL'S DIFFERENTIAL DC AMPLIFIERS FIT IN INSTRUMENTATION SYSTEMS

160 db DC, 120 db 60 cycle common mode rejection with balanced or unbalanced input ■ Input completely isolated from output ■ Input and output differential and floating ■ 5 microvolt stability for thousands of hours ■ .05% linearity, 0.1% gain stability ■ Gain of 10 to 1000 in five steps ■ >5 megohms input, <2 ohms output impedance ■ 120 cycle bandwidth ■ Integral power supply

These are just a few of the many outstanding features of the Model 114A differential DC amplifier . . . features that make this amplifier *really work* in instrumentation systems...features that will help solve *your* instrumentation problems today.

Ideal for thermocouple amplification, the 114A eliminates ground loop problems; allows the use of a common transducer power supply; permits longer cable runs; drives grounded, ungrounded or balanced loads, and can be used inverting or non-inverting.

For additional information and technical literature on this exceptional instrument, write or call KIN TEL – the world's largest manufacturer of precision, chopper-stabilized DC instruments.



KIN TEL 114A differential DC amplifiers ...convenient, interchangeable plug-in mounting in either 6-amplifier 19″ rack mount modules or single-amplifier cabinets.

5725 Kearny Villa Road, San Diego 11, Calif.
Phone: BRowning 7-6700
Representatives in all major cities

KIN TEL
A Division of Cohu Electronics Inc.

For more information circle **31** on inquiry card.

← Circle **30** on inquiry card.

How do you want your Control Valves?

Construction: Single Seated . . . Double Seated. Straight Through . . . Angle . . . Three Way.

Sizes: ½ inch through 16 inches

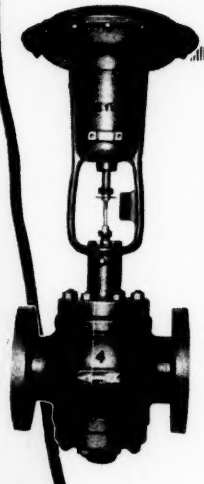
Materials: Iron . . . Carbon Steel . . . Stainless Steel . . . or any other castable metal.

Connections: Screwed . . . Flanged . . . Welded

Plug: Contoured . . . V-Port . . . Equal Percentage . . . Linear

Accessories: Positioners . . . Handwheels . . . Position Indicators . . . Air Sets . . . Reducing Valves

Actuation: Pneumatic . . . Electric . . . Electro Pneumatic . . . Electro Hydraulic



Honeywell has a wide range of standard valves to meet your process control application.

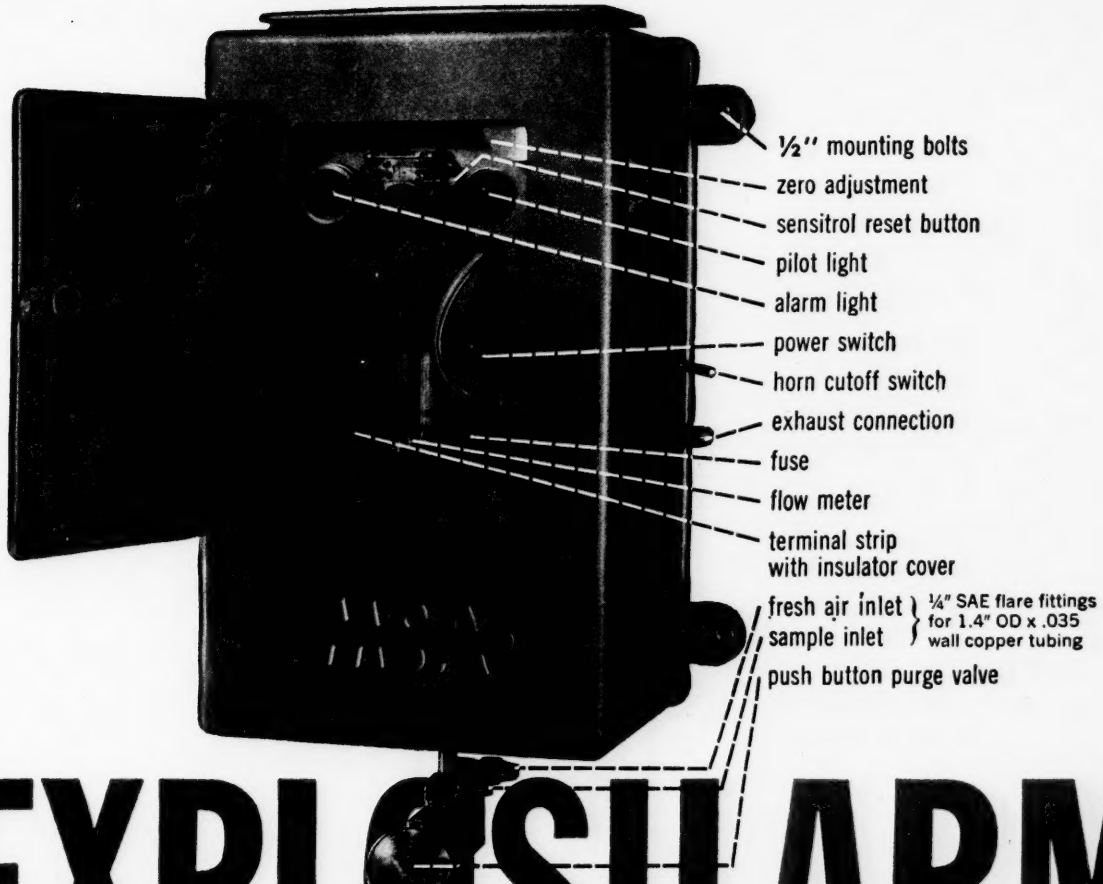
Name the construction, material and size you want . . . there is a Honeywell *quality* control valve to meet your process needs.

Sold and serviced in your local area, the chances are 4 out of 5 that your Honeywell valves can be assembled and shipped in four weeks or less. Approximately 80% of the valves used in industry today are standard . . . and we're set up to handle a 4-week shipment in quantity on standard valves.

Next time you need quality control valves . . . why not do as others are doing? Call your local Honeywell field engineer . . . he's as near as your phone . . . or write for your copy of "Simplified Delivery Schedule." MINNEAPOLIS-HONEYWELL, Fort Washington, Pa.

Honeywell

H HONEYWELL *First in Controls*



EXPLOSILARM

New M-S-A® Explosilarm is small, completely self-contained Combustible Gas Alarm—features low cost and low maintenance

Employed here, in the design of the Explosilarm, is over 30 years of MSA experience in the field of combustible gas analysis. This experience enables us to market a Combustible Gas Alarm offering minimum first cost, negligible installation cost, and very little maintenance. The result is greater economy and safer operations for the user.

Accuracy and reliability of the Explosilarm are predetermined through the use of quality parts and fine craftsmanship. The platinum filaments in the balanced-bridge circuit are specially designed for long service life, interchangeability without matching pairs, and *extreme zero and calibration stability*. The locking panel prevents tampering with controls by unauthorized personnel, and assures proper operation without interruption.

The self-contained feature of the unit is important too. Motor and pump assembly, meter, relay, and all other components, are housed in a cabinet that measures only 8¾" wide by 14¼" high. This cabinet protrudes only 6¼" from the surface on which it is mounted.

An M-S-A Instrument Specialist will be happy to discuss your specific problems with you. Contact him soon. And write us for new bulletin on the operation of the Explosilarm.

MSA

INSTRUMENT DIVISION

Mine Safety Appliances Company
Pittsburgh 8, Pennsylvania

For more information circle **33** on inquiry card.

New DAYSTROM-WESTON MULTI-POINT RECORDER

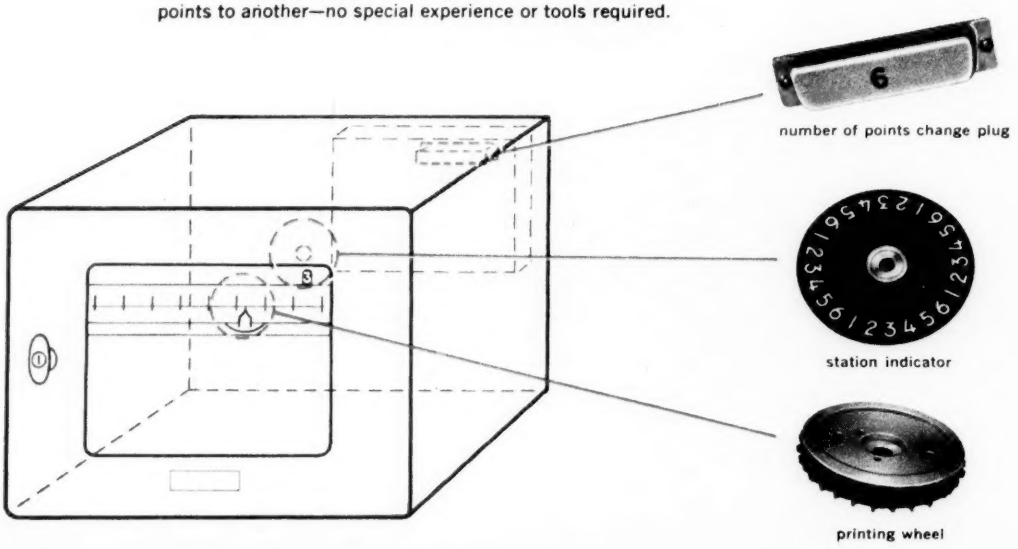
Introduces

INTERCHANGEABILITY—from one number of points to another—one range to another—one chart speed to another.

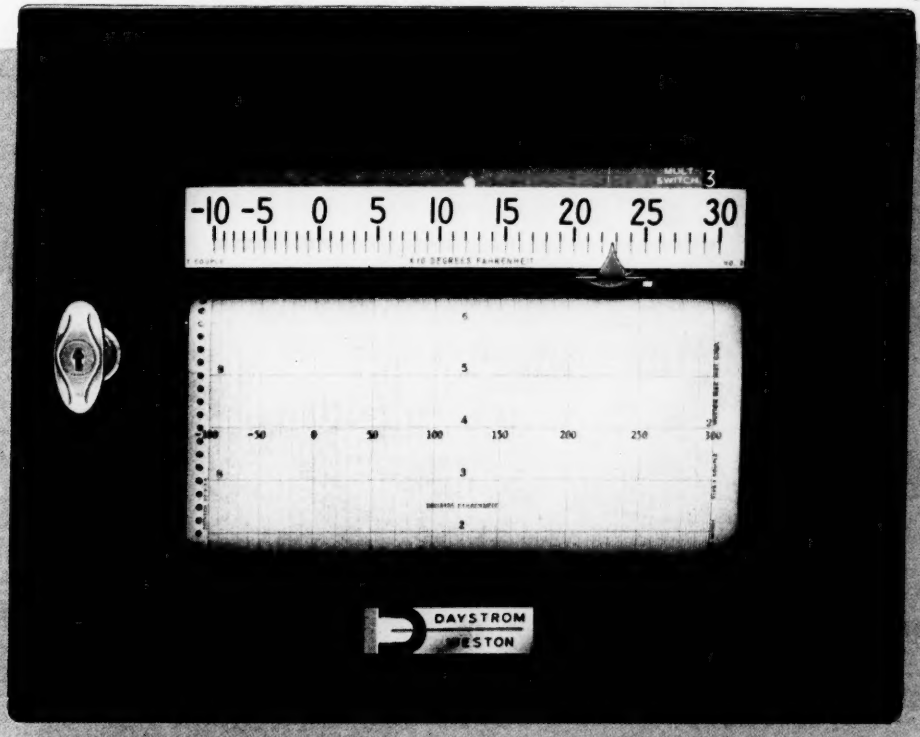
NEW LOW COST – a single instrument: handling from 2 to 24 points! A single price: 15% less than the average multi-point!

39% SMALLER CASE – with full-size chart and full ¼ of 1% accuracy.

Here is all you need to change from one number of points to another—no special experience or tools required.



WITH UNITIZED* design



*** UNITIZATION: the grouping of related components—in Daystrom-Weston Recording Potentiometers—in the simplest, most serviceable, most efficient manner.**

There's tremendous value in this remarkably small instrument—thanks to Weston's *unitized design* and *unique pricing policy*. The size is a big dividend in itself, wherever panel space is at a premium. This is the most compact multi-point recorder—using a full-size chart, and of comparable accuracy (¼%)—ever available. Specially important: a single recorder, offered at a single low price, is easily interchangeable from one number of points to another . . . from one range to another . . . from one chart speed to another! It's so versatile it makes all other multi-point recorders obsolete!

There's none of the clutter or complexity you might expect in an instrument that serves as many functions as this. There's no jungle of wires to hamper inspection and maintenance. Every part is engineered for simplicity—which means trouble-free operation over the years. Components are kept to a minimum, and integrated into compact, rugged panels. Parts are actually more accessible than in much larger instruments.

The new Weston potentiometer recorder accommodates 2, 3, 4, 6, 8, 12, 16 or 24 signals. Changes in the number of recorded points can be made quickly and easily when desired. The unique etched circuit switch is geared directly to the printing head . . . can't get out of synchronization. And this recorder has all of the features that distinguish the other fine instruments in the Weston potentiometer line: simplified range changing with exclusive universal standards . . . high resistance to shock, vibration and corrosion . . . lowest spare parts inventory due to interchangeability of parts.

For more complete information on the Daystrom-Weston *multi-point potentiometer recorder* . . . the *single-point recorder* . . . or the *recorder-controller* . . . call your local Weston representative, or write to Weston Instruments, Division of Daystrom, Inc., Newark 12, N. J. *In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 10, Ont. Export: Daystrom Int'l., 100 Empire St., Newark 12, N. J.*

DAYSTROM-WESTON

Industrial Instruments

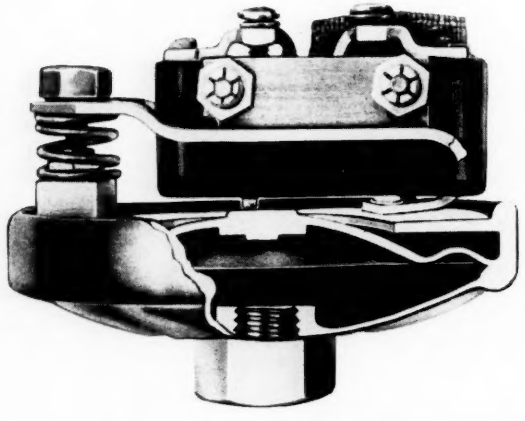
A DAYSTROM UNIT

For more information circle **34** on inquiry card.

NEW PRESSURE SWITCH FOR THE O.E.M.

This *stripped* switch is designed specifically for the Original Equipment Manufacturers who enclose the various controls in a common cabinet. This new pressure and vacuum switch model 402, incorporates the same dependable accuracy and other operating features of the proven *housed* model 420.

Cost and price have been cut by eliminating the housing.



HERE'S THE SIMPLEST DIAPHRAGM PRESSURE SWITCH

WE BUILD IN	WE DON'T USE
EXTREME ACCURACY and DEPENDABILITY maintained during entire operating life due to direct acting design.	LINKAGE and BEARINGS because wear causes the setting of the pressure switch to drift.
EFFICIENT OPERATION IN ANY POSITION which saves the installation costs encountered in mounting a switch using liquid switching elements.	LIQUID SWITCHING ELEMENTS because they make the switch difficult to mount and very critical to vibration.
IMMUNITY TO VIBRATION allowing the switch to be mounted directly on any vibrating or moving equipment.	ACCORDION BELLOWS because they make the pressure switch sensitive to vibration.

To get complete specifications and operating data ask for bulletin 402.

PRESSURE SWITCH DIVISION

Barksdale valves

5125 ALCOA AVENUE • LOS ANGELES 58 • CALIFORNIA

For more information circle **35** on inquiry card.

stock report

Any further information concerning any of the following issues may be obtained from the Research Department, Bache & Co., 36 Wall Street, New York 5, N. Y.

American Stock Exchange:

Price Range For 1958 Thru 5/15/58

	High	Low	Price as of 5/15/58
American Meter	34	27 5/8	33 1/4 34 (1)
Aro Equipment	15 7/8	13 3/4	15 1/8
Barry Controls "B"	7 1/2	4 3/8	7 1/8 - 7 1/2 (1)
Belock Instruments	10 1/8	7 3/8	8 3/4
Benrus Watch	6 7/8	4 7/8	5
Breese Corp.	6 1/2	5 1/4	6
Clark Controller	17 7/8	14 7/8	16 5/8
Clarostat Mfg.	3 3/4	2 7/8	3 1/4
Clary Corp.	4 3/4	2 7/8	3 1/2
DuMont Laboratories	4 5/8	3	3 7/8
Dynamics Corp. of America	4 1/8	2 7/8	3 1/2
Electronics Corp. of America	7 7/8	6 3/8	6 5/8
El-Tronics	3 1/8	1 5/8	2 1/8
Fairchild Camera & Instrument	31 5/8	19 1/2	23 3/4
Globe-Union	17 1/4	14 5/8	15 3/8 - 15 5/8 (1)
Haseltine Corp.	37 1/2	30 1/2	34 1/8
International Resistance	4 5/8	3 3/4	4
Lear, Inc.	6 1/4	4 1/4	5 1/8
National Research	15 1/2	12 7/8	13 7/8
Neptune Meter	23 7/8	19 1/2	22
New Haven Clock	3 1/4	7/8	15/16
Norden-Ketay	6 7/8	2 3/4	2 3/4
Nuclear Corp.of America "A"	1 1/2	1 1/8	1 1/4
Pneumatic Scale	26 1/4	18 1/2	24
Servo Corp. of America	5 1/8	3 3/4	5 1/8
Servomechanisms	8 5/8	6 5/8	8
Wallace & Tiernan	27 1/4	24 3/8	24 7/8
Waltham Prec. Instrument Co.	1 1/2	13/16	1

(1) Not Traded - Bid,Asked

New York Stock Exchange:

Price Range for 1958 Thru 5/15/58

	High	Low	Price as of 5/15/58
ACF Industries	45½	37 3/4	39 1/4
Aeroquip Corp.	21 7/8	16 7/8	19 3/8
Allis Chalmers	26 3/4	22 1/2	22 1/2
American Chain & Cable	45 3/4	39 1/2	43 7/8
American Machine & Foundry	37 7/8	32 1/4	33 5/8
American Machine & Metals	57 1/2	47 1/2	53 - 53 1/8 (1)
American Optical	39 1/8	36	37 1/8
American Tel. & Tel.	177 5/8	167 7/8	176 3/8
Beckman Instruments	25 3/4	18 3/4	18 5/8
Bell & Howell	65 3/8	42	61 1/4
Bendix Aviation	53	44 1/2	47 7/8
Boeing Airplane	42 3/8	34 1/8	40
Bullard	15 3/4	10	14
Bulova Watch	12 5/8	9 3/4	10 7/8
Burroughs	32 1/2	27 5/8	32 1/4
Carborundum	35 7/8	30 7/8	31 3/4
Cincinnati Milling Machine	37	27	34 1/2
Clevite	18 3/8	15 3/4	16 1/2
Columbia Broadcasting "A"	30 1/2	24 1/2	30
Consolidated Electrodynamics	35 1/4	27 7/8	29 7/8
Consolidated Electronics	26 3/4	19 1/2	24 1/2
Cornel Dubilier	16 1/2	12 3/4	15 1/8
Corning Glass	86 3/4	74 5/8	82 1/4
Curtiss-Wright	28 1/8	20 5/8	23 3/4
Cutler Hammer	47	40 1/2	45 1/8
Daystrom	35	30	31 1/4
Douglas Aircraft	74 7/8	54 1/2	60 1/2
Eastman Kodak	107 7/8	97 1/8	105 1/4
Eaton Manufacturing	46 1/4	38 1/2	42 7/8
Electric Auto Lite	30 1/4	25	29 1/2
Elgin Watch	9 3/4	6 3/4	7 3/8
Emerson Electric	37	29	35 3/4
Food Machinery & Chemical	56 1/2	47 1/2	54 3/4
Gamewell	26 1/2	20 1/2	26 1/2
Garrett	35 7/8	27	35 1/8
General Dynamics	65 3/4	55	56 1/4
General Electric	64 1/4	57	58 3/4
General Instrument	8 1/8	4 5/8	8
General Mills	75 7/8	60 1/4	74 1/2
General Precision Equipment	41	29	29 1/2
General Railway Signal	27 1/2	21 1/8	25 7/8
General Telephone	47 3/8	40 3/8	46
General Time	21 5/8	16 5/8	19 1/4
General Tire & Rubber	30	22 1/4	24 1/8
International Bus. Machines	357	300	349 1/2
International Tel & Tel.	35 1/8	29 1/4	33 7/8
ITE Circuit Breaker	41 1/2	36 1/8	37 1/2
Litton Industries	43 7/8	36 7/8	42 1/4
Lockheed Aircraft	47 5/8	38 3/8	46 1/2
Magnavox	37	30 1/4	36
Mallory	88 3/4	23 5/8	25 7/8
Minneapolis-Honeywell	88 3/4	76	84 5/8
Minneapolis Mining & Mfg.	81 1/2	73 1/2	76 1/2
Motorola	42 1/4	35	35 5/8
National Acme	53 1/2	43 7/8	49 3/4 - 50 1/2 (1)
National Cash Register	63	50 1/2	61
North American Aviation	33 1/8	25 5/8	29 1/4
Northrop Aircraft	24 3/4	22 1/8	22 5/8
Otis Elevator	56	40 1/4	53 1/4

Continued on page 1008

AVAILABLE IN JUNE 401-A

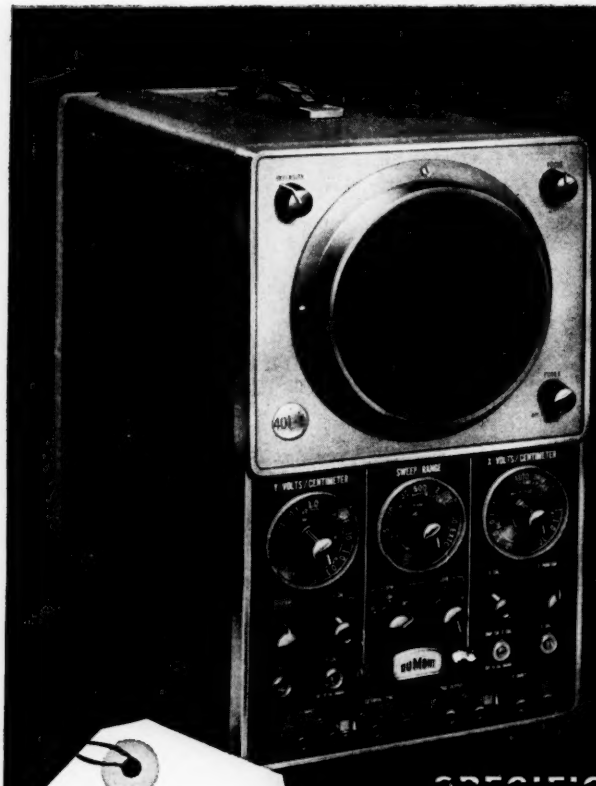
A general-purpose, 5″ oscilloscope of superb design and construction, destined to become the new standard of the industry. This Du Mont scope offers a new high degree of reliability and performance, and incorporates the following features . . .

- X-Y plotting with **identical, calibrated, high-gain** amplifiers.
- Time function plotting on calibrated linear time base.
- Continuous use of X or Y amplifier controls without disturbing calibration. Re-calibration from front panel.
- Diddle-free sync. Automatic or driven sweep selection on front panel.
- **Exclusive:** externally or internally triggered beam brightening during X-Y plots.
- High brightness provides excellent photographic writing rate.
- Sweep speeds available from .25 sec/cm to 5 usec/cm.
- Centimeter calibration.
- Choice of electronic power regulation or Sola voltage-regulating transformer.
- Hand-crafted wiring and high-reliability components for dependability and performance.

What would you expect to pay for this DUMONT scope?

Turn Page →

For more information circle **36** on inquiry card.



DU MONT®

401-A

OSCILLOSCOPE

TYPE 401-A OR TYPE 401-AR (RACK-MOUNTED)

$430

(PRICES F.O.B. CLIFTON, N. J., U.S.A.)

See preceding page for features...

IDENTICAL X- AND Y-AMPLIFIERS: Sensitivity, 10 mv/cm. Sinewave response, extends flat from dc to 3 db down at 100 kc, useful to 500 kc.

SWEEPS: 17 calibrated sweeps available from 250 millisecond/cm to 5 usec/cm. Additional sweep time available, 250 msec/cm for each microfarad of external capacitance. Sweep expansion, up to 30 cm — any 10 cm segment can be positioned on screen.

RELATIVE PHASE SHIFT BETWEEN AMPLIFIERS: With X- and Y-controls at maximum, phase shift will not exceed 3° below 100 kc; at discreet higher frequencies, phase difference can be adjusted to less. Will not exceed 1° below 5 kc with any control setting.

SYNCHRONIZATION: Selection of driven or automatic sweep on front panel. Selection of internal, external or line, both positive and negative polarity, on front panel. Beam brightening gate may be triggered by sync signals during X-Y plotting and for controlled photographic exposure.

CATHODE-RAY TUBE: 5ADP — operated at 3000 volts.

POWER SUPPLY: Three regulated power supplies available for following sources: 115 V, 60 cps, 110 watts. 115 V or 230 V, 50 cps, 110 watts. 115 V, 50 to 400 cps, 140 watts. Regulated r-f high voltage for CRT.

MECHANICAL: 401-A (Bench model), 15½" x 8¾" x 21" Front or rear tilting foot. **401-AR** (Rack mounted), standard 19" rack-mounting, 8¾" high, 18¾" depth behind panel, width behind panel 14⅝", maximum protrusion (handles) in front of panel is 1½". Weight of either unit approximately 45 lbs.

for complete details, write...

INSTRUMENT DIVISION, ALLEN B. **DU MONT** LABORATORIES, INC., CLIFTON, N. J., U. S. A.

For more information circle **36** on inquiry card.

New York Stock Exchange

Continued from page 1000

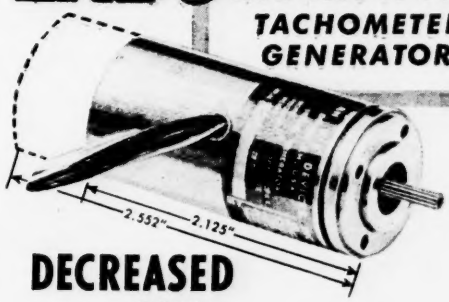
Philco	17 1/8	12 3/8	15
Radio Corp. of America	35	30 1/4	32 7/8
Raytheon	27 1/4	21 1/2	26 1/2
Reliance Electric	35	31	32 1/2- 32 3/4 (1)
Rheem Mfg.	13 3/8	10 1/4	11 1/2
Robertshaw-Fulton	26 3/8	22 1/4	23 1/2
Royal-McBee	21	16	17 7/8
Sangamo Electric	34 3/4	26	26
Sperry Rand	20 5/8	17 1/4	18
Square D	24 5/8	21 1/8	22 3/4
Standard Coil Products	8 5/8	6	8 5/8
Starrett (L.S.)	73	57	73
Stewart-Warner	34 3/8	29	32 1/2
Sylvania Electric	37 1/2	31 1/2	35 1/4
Tel Autograph	7	3 3/4	6 3/8
Texas Instruments	37 5/8	26 3/4	35 5/8
Thompson Products	55 1/4	41 3/8	44 3/4
Tung-Sol Electric	26 7/8	23 1/4	24 1/2
Underwood Corp.	22	12 7/8	19 7/8
Union Carbide Corp.	90	83 7/8	86 3/8
United Shoe Machinery	43 3/8	32	41 3/8
Western Union	18 1/2	15	18 1/4
Westinghouse Air Brake	22 7/8	17 7/8	21 3/8
Westinghouse Electric	65 1/2	57 1/4	57 3/4
Worthington Corp.	55 1/2	45 1/4	53 1/8

1) Not Traded - Bid and Asked

Over-The-Counter

OVER-THE-COUNTER	Quotation as of 5/15/58 Bid	Asked
Aerovox Corp.	3 7/8	4 1/2
Aircraft Radio Corp.	17 1/2	18 1/2
Argus Corp.	19 1/4	20 1/8
Bitel-McCullough	23	24
Electronics Associates	40 3/4	42
Erie Resistor Corp.	5 3/4	6 3/8
Fisher Governor Company	13 7/8	14 1/2
G.M.Giannini	12 1/4	13 1/4
Industro Transistor	2 1/2	2 7/8
Liquidometer Corp.	5	6 1/2
W.L.Maxson	4 3/4	5 1/8
Penn Controls, Inc.	14 1/2	15 1/2
Speer Carbon, Inc.	23	24 1/4
Sprague Electric	26 1/2	27 3/4
Taylor Instrument	29	30 1/4
Telecomputing Corp.	4 3/8	4 3/4
Topp Industries	9 1/4	9 3/4
Varian Associates	16 7/8	17 3/8
Vitro Corp. of America	17	17 5/8

EAD's New Size 11 Servo TACHOMETER GENERATOR



DECREASED SIZE... INCREASED EFFICIENCY

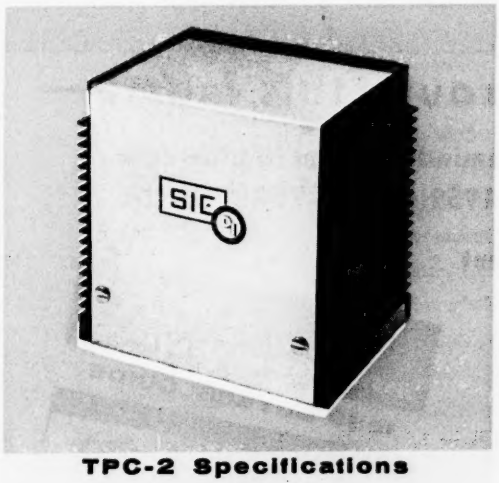
Precision, Performance, Price— Get all 3 at EAD

EAD's precision size 11, 115-volt motor tachometer is now available in a smaller package—and achieves improved electrical characteristics! It delivers 0.6 volts per 1000 rpm with 19 millivolts of total null. Lower nulls are available. Upper temperature reading is 150°C. EAD's new unit is available in variations of voltages and power ratings for transistor operations, variations in shaft and mounting configurations, etc.... and may be ordered with precision gear heads to your requirements. Write for more information.

EAD Eastern Air Devices, inc.

347 CENTRAL AVENUE
DOVER, NEW HAMPSHIRE

For more information circle **37** on inquiry card.



TPC-2 Specifications

Input Voltage:	12 vdc nominal
Input Current:	6.2 a full load, 0.8 a no load
Maximum Rated Output:	400 ma @ 150 vdc or 200 ma @ 300 vdc
Efficiency:	Better than 80% at full load
Load Regulation:	Less than 15%, No Load to Full Load Less than 8%, One-Half Load to Full Load
Ambient Temperature:	—40° F. to + 150° F.
Ripple:	0.5% full load, RMS basis
Dimensions:	3¾" H x 3$^{25}/_{32}$" L x 2¾" W
Weight:	1¾ lbs.
Price:	$125.00 (F.O.B. Houston, Texas)

There's an SIE Power Supply to meet any application

DC to DC
AC to DC

New circuit developments now enable SIE to offer transistorized power supplies to cover all possible applications: DC to DC, DC to AC and AC to DC; regulated and unregulated, high and low voltage and current ratings, for laboratory, industrial and military installations.

Especially significant is SIE's new circuit which permits operation from DC input voltages above 30 volts without requiring special transistors.

In the 60 watt TPC-2, an ingenious case design permits it to be used in free air without a heat sink, or attached to a heat sink in a confined space.

Check these specifications. They will suggest many new applications for these latest SIE contributions to *Electronic Instrumentation for Industrial Progress.*

SIE

SOUTHWESTERN INDUSTRIAL ELECTRONICS COMPANY

2831 POST OAK ROAD • P O BOX 13058 • HOUSTON, TEXAS

For more information circle **38** on inquiry card.

SALES MANAGERS: You route this memo—

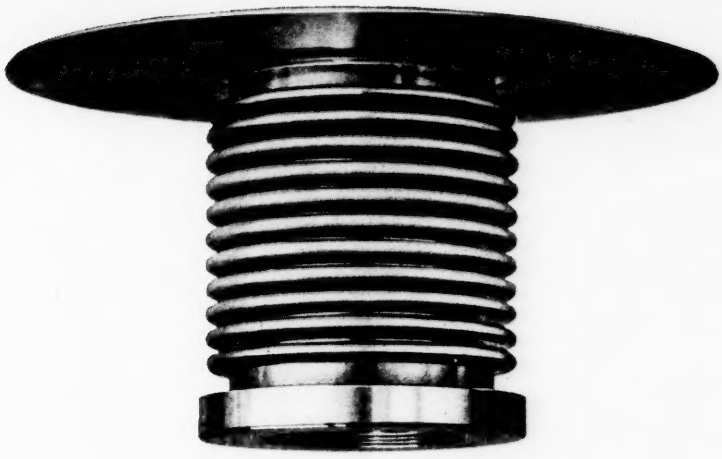
to your ad department and agency—reminding them to plan now to advertise in the 1959 I&A BUYERS' GUIDE

Industry's only instrument-control equipment buying directory, the Guide offers you . . .

- Entree to 23,000 buyers of instrument and automatic control equipment.
- A directory listing equipment, names and addresses of 3,000 manufacturers.
- Twenty-three years experience selling to OEM and end users.
- Year 'round contact with industry's big buyers.

Reserve your ad space now. Forms close August 15-29—write:

INSTRUMENTS PUBLISHING CO., INC.
845 Ridge Ave., Pittsburgh 12, Pa., FAirfax 1-161



CORRUGATED SLEEVE

shields working parts

Consolidated Safety Relief Valve with Sealing Bellows. Type 1900-30 Series, Sizes: 1½" x 2" to 8" x 10".

A durable, two-ply stainless steel Sealing Bellows in Consolidated Safety Relief Valves isolates contaminants, corrosion or viscous fluids from the working parts. The Bellows is balanced with the seating surface. Capacity is less affected by variable back pressure, so you can use smaller discharge piping and reduce the cost of pressure-relieving systems.

Full-rated relieving capacity is certain at all positions of the single blowdown adjusting ring because a fixed maximum secondary orifice provides full lift at 10% overpressure. Even with superimposed back pressure in the relieving system, valve action is consistently positive.

Protection of working parts is but one of many reasons why Bellows Type Consolidated Safety Relief Valves assure absolute protection for personnel and facilities. Write for details, including facts about the Standard valve that you can convert to the Bellows type in your own shop. Ask for Catalog 1900.

MAXWELL MANNING M&M & MOORE INC. TRADE MARK

CONSOLIDATED SAFETY RELIEF VALVES

A product of

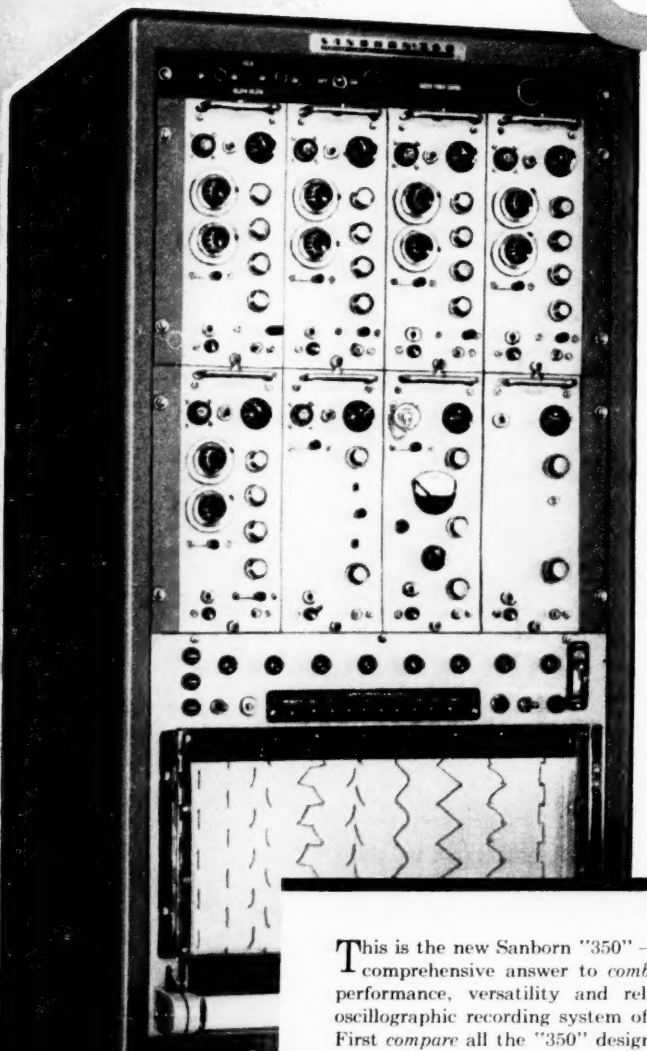
MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Tulsa, Oklahoma
In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

For more information circle **39** on inquiry card.

only one direct writer

...THE NEW SANBORN 350



6- OR 8-CHANNEL OSCILLOGRAPHIC RECORDING SYSTEM

6- OR 8-CHANNEL SYSTEM IN ONE CABINET

Each module of four Preamplifiers takes only 10½" of panel space, complete Recorder-Power Amplifier package only 17½". All controls are on front panel. Total panel space, including ventilating fan and master power panel, 49". Entire system normally installed in one cabinet 22" x 22" x 73¾", to place recorder and controls at convenient height.

FREQUENCY RESPONSE TO 120 CPS

Essentially flat from 0 to 100 cps at 10-division amplitude peak-to-peak, 3 db down at 120 cycles. Built-in pre-emphasis circuit in Power Amplifier.

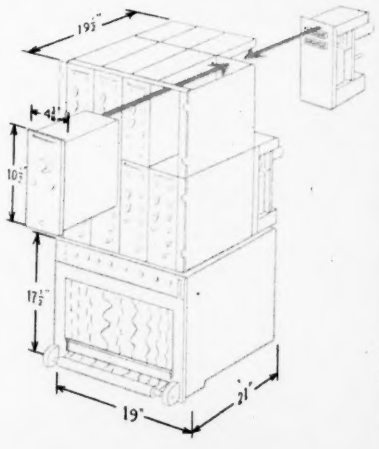
HEAVY CURRENT FEEDBACK, TRANSISTORIZED POWER AMPLIFIERS

Long term drift less than 0.2 div. over 20°C. changes, short term less than 0.1 div. for 24 volt line voltage changes. Response time 4 ms. In-phase rejection ratio 100:1. Gain stability better than 1% with 20°C. and 20 volt changes.

LINEARITY: 0.2 DIVISION OVER ENTIRE 50 DIV. CHART WIDTH

This is the new Sanborn "350" — today's most comprehensive answer to *combined* improved performance, versatility and reliability in an oscillographic recording system of compact size. First *compare* all the "350" design and performance improvements . . . then consider *the many ways they can help you* do *more kinds* of measurement and recording, with *more* accuracy, speed, convenience and reliability.

Experienced sales-engineering representatives in all principal cities. Call the one near you for complete "350" facts.



gives you all these features

INTERCHANGEABLE PREAMPLIFIERS WITH INDIVIDUAL POWER SUPPLIES

Compact, plug-in units with 4 3/16" x 10 1/2" panels. Present types include Carrier, Servo Monitor (demodulator), DC Coupling, True Differential DC. Can be used separately for driving optical oscillographs, 'scopes, tape recorders, etc.

LIMITER CIRCUIT AHEAD OF POWER AMPLIFIERS ASSURES DAMPING AT ALL TIMES

Limiting at input prevents amplifier saturation or cut off; so that galvanometer damping is never lost.

RUGGED, RELIABLE, LOW VOLTAGE, LOW IMPEDANCE GALVANOMETERS

Fewer turns of heavier wire and completely enclosed coil increase reliability. High torque (250,000 dyne-cm.). Hysteresis level less than 0.1 division. Designed for easy replacement in field.

RECORDER-POWER AMPLIFIER PACKAGE IN ONLY 17½" OF PANEL SPACE

Integral, tube-free package includes eight power amplifiers and power supply, which use power transistors and solid state rectifiers. Operates on 115 volts, 60 cycles. Simple paper loading from front. Individual stylus heat controls, chart speed pushbuttons, motor switch, timer-marker switch, fuses, paper footage indicator all on front panel. Connectors for input signals, output monitoring (±1 volt with respect to ground from 2.5 ohm source) and complete remote control provided at rear.

VELOCITY FEEDBACK DAMPING

True damping by velocity signal from separate winding over galvanometer driving coil. Damping control accessible from front of Recorder for easy adjustment.

GALVANOMETER NATURAL FREQUENCY 55 CPS

Higher natural frequency provides higher over-all system frequency response.

INKLESS RECORDINGS IN TRUE RECTANGULAR COORDINATES

Heated stylus creates sharp, smudge-proof trace on plastic coated Permapaper. Chart channel width 1 9/16" (approx. 4 cm), ruled in 50 div. of 1/32" each.

RECORDER-AMPLIFIER UNIT HAS 0.1 VOLT/CHART DIV. SENSITIVITY

Can be used alone, when preamplification is not needed. (Three complete 8-channel Recorder-amplifier-power supply units can be mounted in one cabinet.)

ELECTRICAL PUSHBUTTON CHART SPEED CONTROL, WITH PROVISION FOR REMOTE CONTROL

Any of nine speeds (0.25, 0.5, 1.0, 2.5, 5, 10, 25, 50, 100 mm/sec.) instantly selectable by pushbutton. Plastic strip for channel identification markings.

QUALITY COMPONENTS USED THROUGHOUT

JAN components used wherever practicable; for example, note in the photos hermetically sealed MIL-T-27 power transformers, MIL-approved electrolytic condensers in all power supplies, ruggedized premium-type tubes in Preamp power supplies, etc.

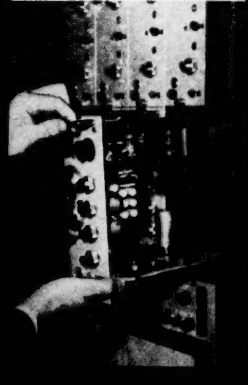
(ALL DATA SUBJECT TO CHANGE WITHOUT NOTICE)

For more information circle **40** on inquiry card.

SANBORN COMPANY
INDUSTRIAL DIVISION
175 WYMAN STREET, WALTHAM 54, MASS.

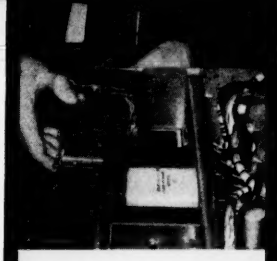
350

Any "350" Preamplifier installs easily in any channel. Electrical connections made by mating connectors on Preamp and Power Supply.



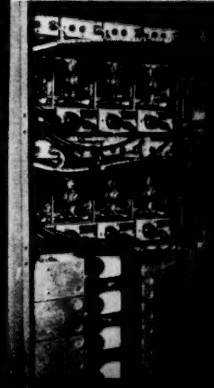
Quick, simple paper loading is done from front; hinged viewing window is removable. About 8" of record visible. All controls on front panel.

Any of nine chart speeds can be instantly selected by pushbutton. Remote control of all functions provided by connectors at rear.

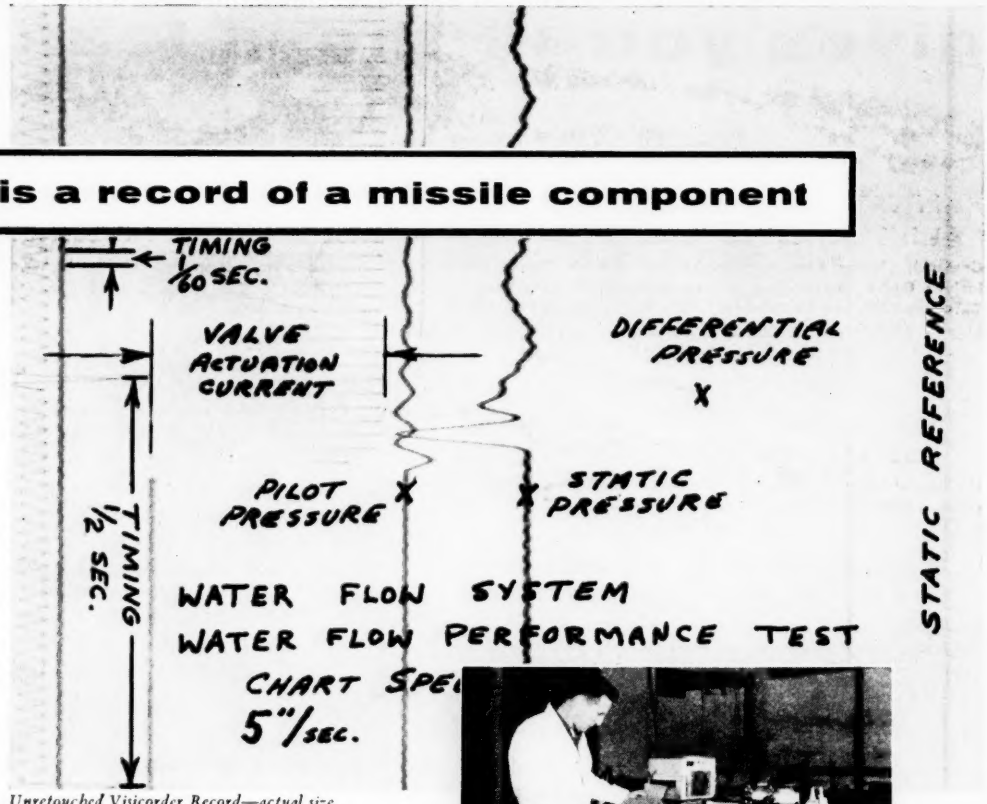


Recorder back plate holds eight plug-in Power Amplifier modules (one shown unplugged in photo), four on either side of Power Supply section. Entire back plate removable for servicing.

Eight-channel "350" from rear, showing (upper half) eight individual Preamp Power Supplies on four-unit module frames, and below them, Power Amplifiers and Power Supply on rear of Recorder Assembly.



This is a record of a missile component



Unretouched Visicorder Record—actual size

Wyle Laboratories in El Segundo, California, have used a battery of four Visicorder consoles like the one shown below to run a series of tests on a vital missile component. In the Wyle test project, the unique Visicorder consoles are easy to operate. Most parameters are low frequency, requiring response on the order of 5 to 60 cycles.

The two calibrator control panels in each Visicorder console accommodate 10 plug-in balance and matching units—designed to match tachometer generators, pressure transducers, thermocouples, expanded-scale voltmeters, etc., to the Heiland galvanometers.

Dick Johnson, Instrumentation Branch Head at Wyle, says, "This system, I feel, is one of the most efficient instrumentation consoles in operation. Set-up and calibration time has been reduced by the use of Visicorders by approximately 50%. This is due to the simplicity of operation and trouble-free performance. There are no inking pens to clean, high-gain amplifier maintenance, and so on, and we can also use these consoles together to form systems of more than six channels."

Tom Jackson, Wyle engineer, examines Visicorder record

The HONEYWELL VISICORDER is the first high-frequency, high-sensitivity direct recording oscillograph. In laboratories and in the field everywhere, instantly-readable Visicorder records are pointing the way to new advances in product design, rocketry, computing, control, nucleonics . . . in any field where high speed variables are under study.

To record high frequency variables—and monitor them as they are recorded—use the Visicorder Oscillograph. Call your nearest Minneapolis-Honeywell Industrial Sales Office for a demonstration.

Honeywell

Industrial Products Group

Reference Data: Write for Visicorder Bulletin

Minneapolis-Honeywell Regulator Co., Industrial Products Group, Heiland Division, 5200 E. Evans Ave., Denver 22, Colorado

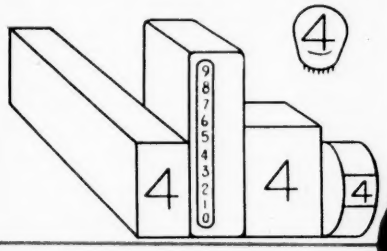
For more information circle **41** on inquiry card.

Circle **42** on inquiry card. ⟶

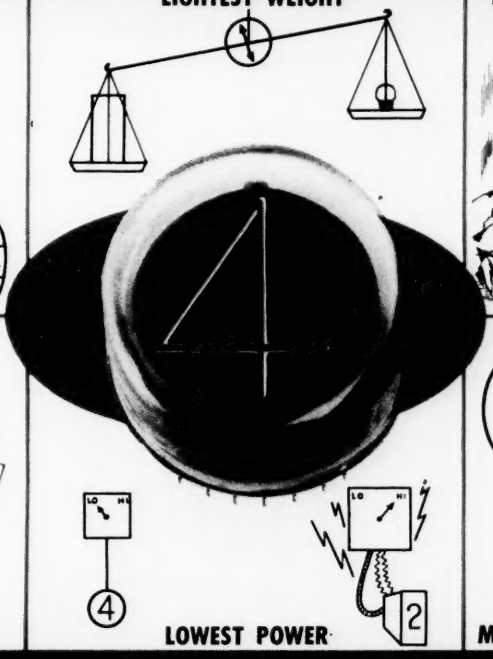
only NIXIE

HAVE THESE EXCLUSIVE FEATURES

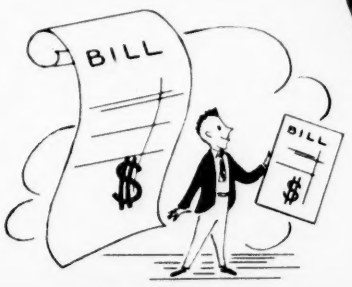
SMALLEST VOLUME FOR NUMBER SIZE



LIGHTEST WEIGHT

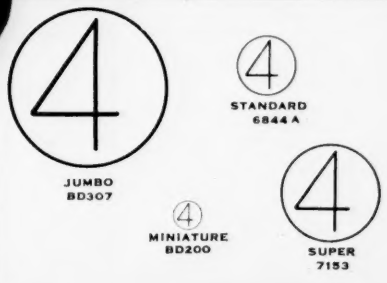


MAXIMUM TEMPERATURE SHOCK AND VIBRATION SPECS



LOWEST COST

LOWEST POWER



MOST READABLE FOR NUMBER SIZE

SOME TYPICAL NIXIE APPLICATIONS

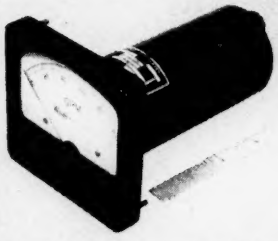
Burroughs Corporation

ELECTRONIC TUBE DIVISION

Flow Measurement and Control by Waugh

Six precision measurement devices . . . a sampling of the many developed through Waugh's creative engineering. When planning for the most advanced systems, take advantage of Waugh's ability to meet tomorrow's requirements today.

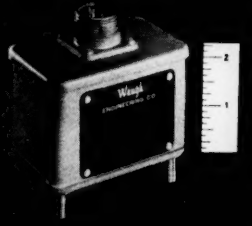
FLOW RATE INDICATOR FR-305



Combines indicating meter with transistorized frequency-to-voltage converter in a single compact package.

- Optional 115v ac or 28v dc power supply.
- Accurate to 1% of full scale.
- Custom scales for all flow ranges and measurement units.
- 250° scale instruments also available.

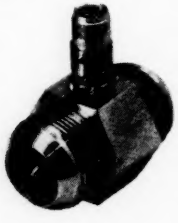
TRANSISTORIZED FREQUENCY-TO-VOLTAGE CONVERTER FR-300 SERIES



For flow rate or R P M. measurements. Combines compact size with high stability and precision.

- 3 x 2 x 2⅛ overall size.
- 0-5 volts output. 0-1 milliampere also available.
- Better than .002% per degree temperature coefficient.

TURBINE FLOW SENSOR FL SERIES



Converts fluid flow into A.C. frequency proportional to flow rate.

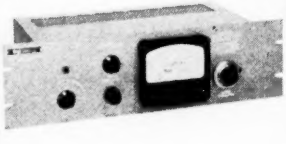
- Exclusive design features low pressure drop . . . high reliability.
- Special series available for gas measurement.
- High frequency models measure flow transients up to 50 cps.

TRANSISTORIZED FREQUENCY DETECTOR FD-100

Provides instantaneous trip-signal when input frequency goes above or below preselected limit.

- Used as overspeed trip with tachometer generators or as flow limit switch with turbine flow sensors.
- Trip point accurate within 1%.
- Response time 10 milliseconds maximum.
- 28v output to operate solenoid or relay.

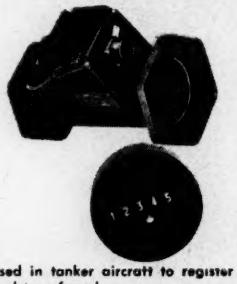
PULSE RATE CONVERTERS SERIES FR-100 AND 200



For converting frequency output of turbine flowmeters or tachometer generators into a DC signal.

- Cabinet or relay rack styles.
- Multiple input channels with built-in indicator.
- 5 to 3000 cps. input frequency range.
- High frequency model gives transient response to 50 cps.

FLIGHT REFUELING FLOWMETER



Used in tanker aircraft to register total fuel transferred.

- Complete system includes sensor and indicator only; no intermediate devices.
- All-transistor circuitry provides high reliability; no mechanical switches.
- Includes circuit to turn on indicator light when fuel is flowing.

Bulletins giving complete physical and technical data on these and other Waugh products will be sent on request. Our engineering staff is available to assist in the development and manufacture of other precision components you may require.

Waugh

ENGINEERING CO.

7842 Burnet Ave. • Van Nuys, Calif.

Sales representatives in principal cities

For more information on Converters circle **43**, on Flowmeters circle **44**, on Detectors circle **45** on inquiry card.

events

July 14-25

Special Summer Program in the Physics of Infrared Radiation, Massachusetts Institute of Technology. For information write Dr. Richard C. Lord, Dir. of Spectroscopy Laboratory at M.I.T.

July 24-25

Fifth Annual Symposium on Computers and Data Processing sponsored by the Electronics Div., Denver Research Institute, University of Denver, at Albany Hotel, Denver, Colo. For information write C. A. Hedberg, Head Electronics Div., Denver Research Institute, U. of Denver, Denver 10, Colo.

July 28-August 1

Gordon Research Conference on Instrumentation, Colby Jr. College, New London, N. H. For information write Dr. W. George Parks, Dir., Dept. of Chemistry, University of Rhode Island, Kingston, R. I.

July 29-31

3rd Annual Exhiborama and 2nd Annual Symposium, Society of Photographic Instrumentation Engineers, at Statler Hotel, Los Angeles. For further information contact Bob Jakobsen, Jakobsen Advertising Agency, Inc., 2201 Park Drive, Los Angeles 26, Calif.

August 13-15

7th Annual Conference on Industrial Applications of X-ray Analysis at Albany Hotel, Denver, Colo. For further information contact William M. Mueller, Metallurgy Div. Denver Research Institute, University of Denver, Denver 10, Colo.

August 19-22

WESCON (Western Electronics Show and Convention) co-sponsored by the San Francisco and Los Angeles sections of IRE and the West Coast Electronic Mfg. Assn., Pan Pacific Auditorium and Ambassador Hotel, Los Angeles, Calif. Write Ted Shields, General Public Relations, Inc., 607 S. Hobart Blvd., Los Angeles 5, Calif.

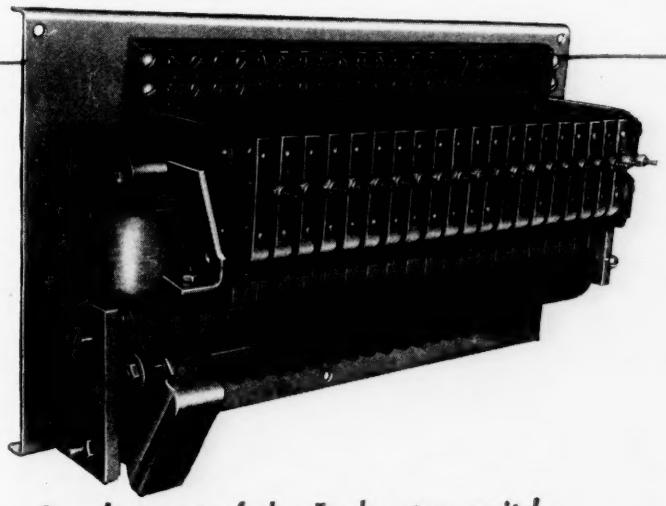
Sept. 15-19

13th Annual Instrument Society of America Conference and exhibit will be held in Philadelphia. For further information contact H. S. Kindler, Dir. of Technical Programs, Instrument Society of America, 313 Sixth Avenue, Pittsburgh 22, Pa.

Oct. 13-15

1958 National Electronics Conference —the 14th Annual Forum on Electronic Research, Development and Application sponsored by the American Institute of Electrical Engineers, Illinois Institute of Technology, Institute of Radio Engineers, and Northwestern and Illinois Universities, Hotel Sherman, Chicago. For information write National Electronics Conference publicity chairman, c/o Illinois Bell Telephone Co., 208 W. Washington St., Chicago 6, Ill.

NEW EAGLE STEP SWITCH offers a special approach to automatic process control step sequencing



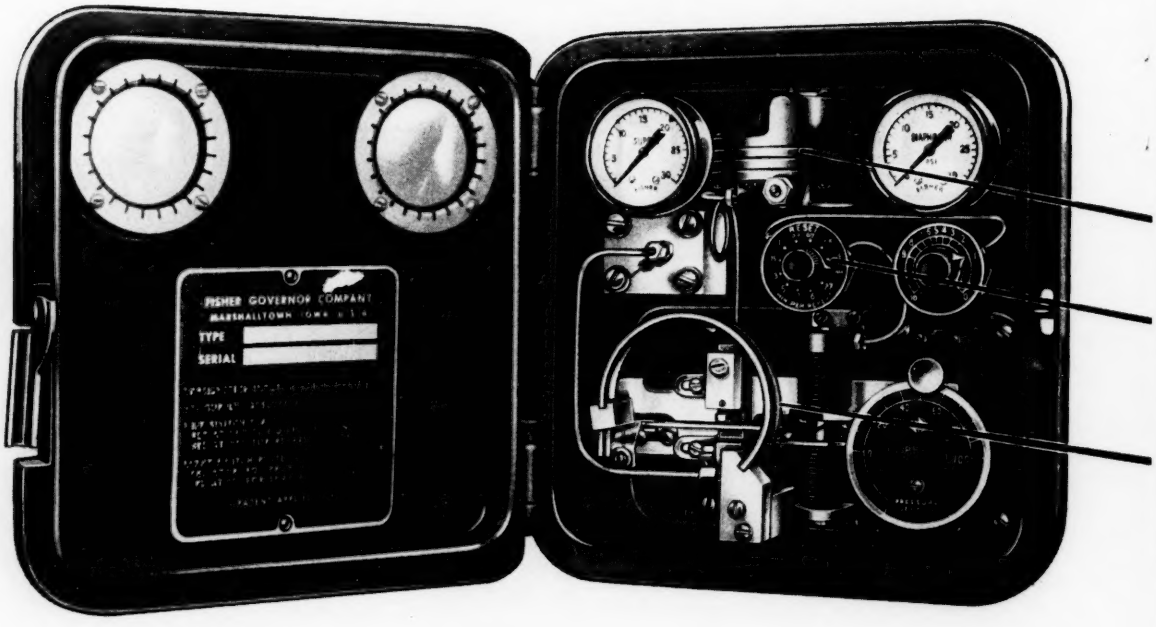
Development of the Eagle step switch now provides a new approach to process control. Any type of time or sensing device can be used to advance the switch, and a multiplicity of load circuits can be operated in any combination — up to 19 circuits. Devices used to actuate the switch include: push buttons, limit switches, timer intervals, pressure change components, level control apparatus.

The new switch also provides a sequencing interlock when used with multiple indexing circuits. A mechanical circuit interlock by cam action eliminates interlocking relays. Ten ampere switch contacts control load switches direct — no need for load relays. Switch is built with 115 volt coil, and is of heavy duty industrial switch construction throughout.

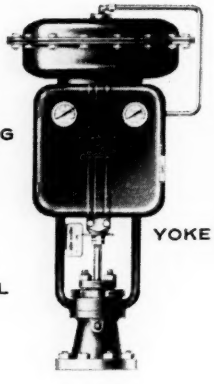
Make certain you get complete information on this new switch. Send for Bulletin 780. Eagle Signal Corporation, Dept. IA-658, Moline, Illinois.

For more information circle **46** on inquiry card.

Basic Simplicity...faster



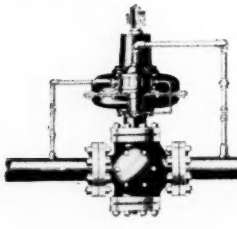
SURFACE MOUNTING



YOKE MOUNTING

FLUSH PANEL MOUNTING

PERFORMANCE DATA	
Test	**Results**
Air or Gas Consumption with 15 psi Output Pressure	Minimum at 10 or 0 Proportional Dial Setting—2 cfh Maximum at 5 Proportional Dial Setting—23 cfh
Resolution Sensitivity	Minimum Change Required in Measured Variable to Produce an Effective Movement of Final Control Element is 0.1% of Bourdon Tube Rating.
Repeatability	Ability of Wizard to Reproduce Its Output Signal for a Given Pressure Setting is 0.5% of Bourdon Tube Rating
Resonant Frequency	Unaffected at Usual Motor and Turbine Speeds.
Temperature Effects	Under Cold Box Test at —20° and Simulated Sun Test from 80° to 212°F Control Pressure Remained Within ±1% of Bourdon Tube Rating.



IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD...

FISHER GOVERNOR COMPANY

response...greater stability

the WIZARD II PRESSURE CONTROLLER

with New and Improved Features

1. **VOLUME RELAY** for faster response to pressure changes.
2. **RESET FEATURE** for greater stability and pin point control, assuring perfect metering, even on multi-stage meter runs.
3. **WIDE RANGE** brass, steel or stainless steel Bourdon tubes cover a range of from 25 to 10,000 psi. Bellows assemblies for low pressure regulation in ranges from 0 to 25 psi.

Again FISHER engineering produces features the industry needs to do a better job

The Wizard II has been designed to specifically meet the demands of modern, complex systems requiring closer control. The Wizard II retains all of the basic simplicity, accuracy and dependability of the Wizard 4100U, plus its own exclusive features.

The new design consists of two sub-assemblies encased in a weather proof die cast aluminum housing which is provided with a ¼" pipe threaded vent for gas service. Either assembly can be removed without disturbing line connections.

The upper assembly consists of two gauges, relay and proportional band adjustment. The lower assembly includes the set point adjustment, proportional bellows, Bourdon tube and nozzle. Each assembly is assembled and calibrated before mounting in the case. The case can be mounted on a flush panel, a wall or on the yoke of the control valve.

Careful and exhaustive tests have conclusively proved that the Wizard II measures up to rigid Fisher standards.

A completely descriptive and illustrated bulletin on the Wizard II is yours for the asking. Write for Bulletin No. D-4150.

The original Wizard I is still available for those applications not requiring volume relay and reset features.

CHANCES ARE IT'S CONTROLLED BY...

FISHER®

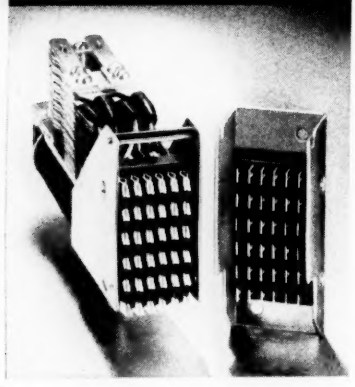
SINCE 1880

Marshalltown, Iowa / Woodstock, Ontario

For more information circle **47** on inquiry card.

STROMBERG-CARLSON

Type "A" Relays with Plug-in mountings



For fast, easy removal and replacement you can get Stromberg-Carlson Type "A" Relays with *plug-in mountings.*

The Stromberg-Carlson Plug (illustrated above) automatically locks the relay in place and guarantees a low-resistance connection between plug and socket. Its 36 terminals provide enough connections for practically all relay applications. Coils and contacts are wired to terminals as your needs dictate. Contacts can be furnished in silver, palladium, gold alloy or palladium-silver alloy.

Spring combinations possible with this assembly are 17 Form A or Form B; 10 Form C or Form D.

Also available in an "A" Relay is a plug used with commercial radio type sockets. It can mount relays with 8, 9, 12 or 20 connections.

For technical details and ordering information, send for Bulletin T-5000R, available on request. Write to:

S-C STROMBERG-CARLSON

STROMBERG-CARLSON

A DIVISION OF GENERAL DYNAMICS CORPORATION
TELECOMMUNICATION INDUSTRIAL SALES
113 Carlson Road, Rochester 3, N. Y.

Electronic and communication products for home, industry and defense

For more information circle **48** on inquiry card.

Panhandle Pete

From the Horse's Mouth

TO COMBAT the flood of rumors appearing in the press that Automation is reducing the nation's work force, causing inflation, aiding juvenile delinquency and causing people to wonder where the yellow went, the editors of *INSTRUMENTS AND AUTOMATION* have interviewed leading industrialists. Our first interview is with that jovial Sales Manager of WESCO!, Mr. Waldo I. Klapsaddle, Jr., well-known figure in the instrument industry.

Question: Do automatic controls cause unemployment?

As I told the Senators investigating this problem—categorically no. You can quote me on that. Automation makes jobs. When our economy was expanding, it was expanding because of automation. The only thing that stopped the expansion was that not enough automation was applied. Could industry exist today without the telephone?

Question: Do you seek more automatic operation in your plants?

We seek automatic operation wherever possible. We have entire teams of engineers investigating every possibility for automatic control throughout our plants. We are so sensitive to new techniques that we have automated our mailroom, delivery room, production room and lavatories. Nothing goes on in our plant that isn't timed, tabulated, and watched by me personally. We believe in automatic operations. I just fired a man yesterday for taking 6 minutes to do what he should have done in 4¼.

Question: What do automatic controls mean to your business?

I guess you never heard of our business. We make gas analyzers, digital computers, air filters, unguided missiles, system analyzers, and digital computers. We have one of the most efficient businesses in the country. We can say that we lost more money last year fooling around with systems and computers than anybody else in the game. Yes sir, automatic control is our business, and we honestly state that we believe in it without reservation. What's good for automatic control is good for the country. You can quote me on that.

Question: Do you have anything new on the drawing boards?

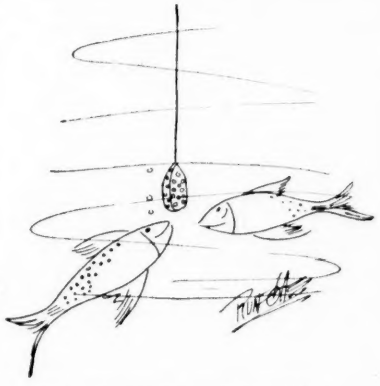
I would like to mention the research we are performing on political aids. This is an election year and we at WESCO! don't just stand around with our backs up against the hot pipes and let business go to pot. For the politician who wants to keep up to date we are building The Mark IV Wind Recorder which, in combination with our Little Zephyr thermometer, will allow the politico to not only know where the winds blow but also whether they blow hot or cold. We practically guarantee an election. In fact, we will guarantee almost anything. Automatic control is simply wonderful.

Question: Are we lagging the Russians in scientific progress?

We are designing things they haven't even thought of yet. Despite all the scoffers I believe we are ahead of the world in most important things—automatic transmissions, automatic car window operators, automatic bill printers, automatic insurance calculators, automatic alerts, pay-tv, etc.

Question: Do you think that the factor of population growth is a boom to your industry?

There's no doubt that the increase in the birth rate means that more



"Here's that marine recorder again . . . Let's go into our act . . ."

people are, er, ha, ha, ha! More people mean bigger markets, an expanding economy, a fast-growing society. Of course, too many people sometimes get out of work, and most of them sure can aggravate you. But there is no substitute for people when you want a big market. And most of them need plenty of control.

Question: Is the government defense program efficient or wasteful?

Almost everything the government does is very wasteful, but I wouldn't say that about the defense program. No sir. The government should do everything in its power to increase the efficiency of our defense effort. And taxes should be reduced. You can quote me on that.

Question: What is the greatest stimulant for your industry?

Several factors must be mentioned here, of which sales is one. As long as somebody will buy this cr-, er controls, we will grow. Our market is as big as industry itself. Today the government is the biggest stimulant there is, but in case it ever stops meddling into business, as I have advocated strongly for years, we can fall back on industry.

Question: Is our educational system supplying you with good engineers?

We should immediately start teaching college-level math and science in all high schools. Also, we should group students by ability level, so that the brighter students are in one group, the average in another, the dumb ones in a third class, instead of putting all together in one class. Classes should be smaller and better.

Question: How can you do this with the present number of teachers?

This is a detail for the schools to solve. I have analyzed the problem.

Question: Will the shortage of engineers soon end?

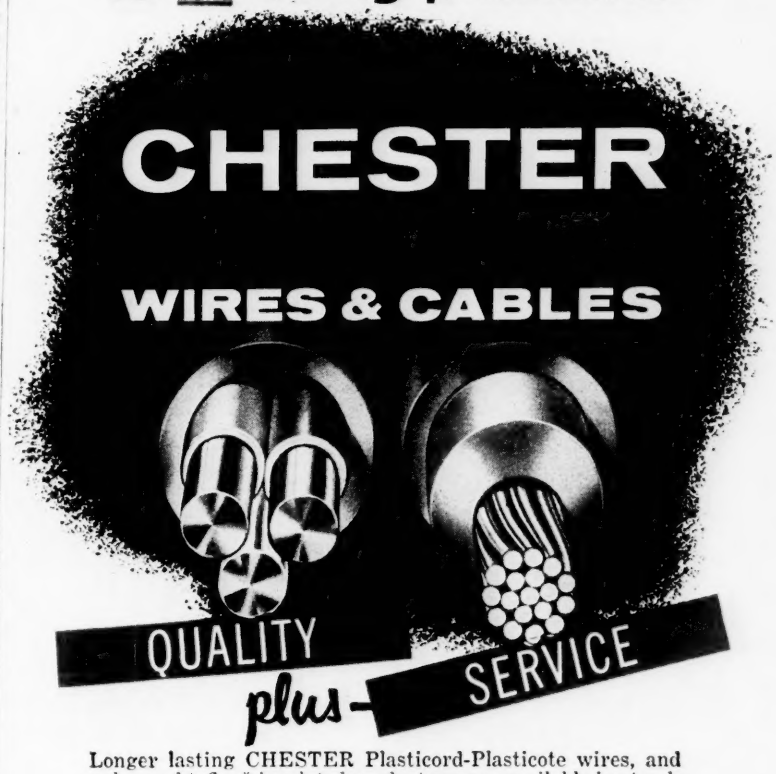
It all depends on your definition of "shortage," "engineers," "end," and "soon." The answer is yes and no. For example, we had no trouble hiring twenty engineers recently at salaries starting at $23,500. We need them because we might bid on a government contract next year.

Question: Are companies stockpiling engineers?

No. You can quote me on that.

Panhandle Pete

Double-barrel solution to all wiring problems!



Longer lasting CHESTER Plasticord-Plasticote wires, and nylon and teflon* insulated conductors, are available in standard or custom constructions for every requirement. All are service-proven for complete reliability for the specific application for which they are engineered. And equally reliable, is the service behind them... from "crash" deliveries to engineering assistance on the design of special purpose constructions!

"Chesty" says: FOR EASIER INSTALLATION AND LONGER LASTING DEPENDABILITY, WIRE IT WITH CHESTER!

—for Smooth Pliability with Super-Durability

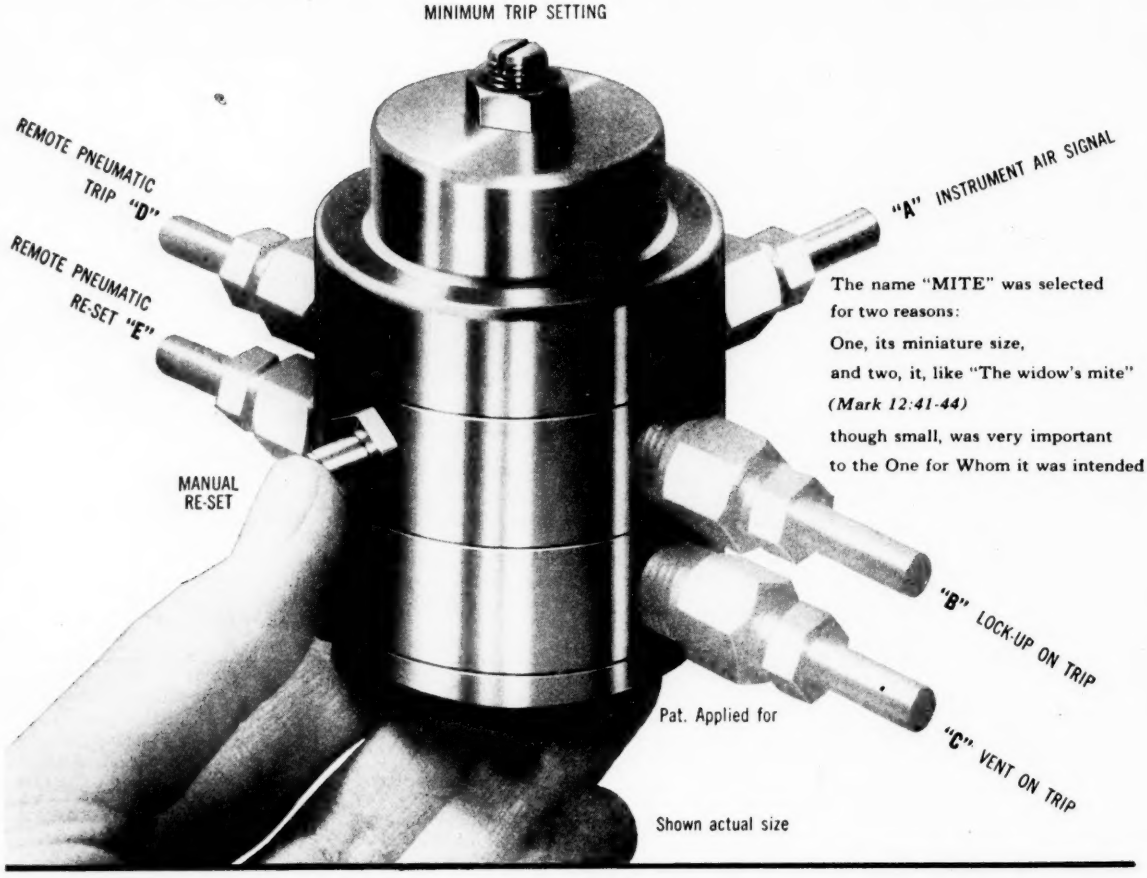
"Airsac" TV Lead-in Wire
Appliance Wire
Annunciator Wire
Annunciator Cable
Antenna Loop Wire
Braided Wire
Coaxial Cable
Custom Cable Constructions
Flame Retardant High Voltage Wire
Flexible Bell Cordage
High Frequency Test Lead
High Frequency Lead Wire
Intercom, Control and Audio Cable
Microphone Cable
MIL Hook-up Wire
Miniature Wire and Cable
Multiple Conductor Cable
Nylon Coated Wire Overbraids
"Parallead" TV Lead-in Wires
Phonograph Pick-up Cable
Photoelectric Cell Cable
Rotor Cable
RVC-300 Apparatus Wire
Shielded Cable
Teflon Lead Wire
Telephone Bridle Wire
Telephone Cable
Telephone Inside Wire

*DuPont Tradename

CHESTER CABLE CORP.
A Subsidiary of Miami Copper Company
5 HILL STREET, CHESTER, NEW YORK, U.S.A.
PIONEER PRODUCERS OF PLASTIC INSULATED WIRES AND CABLES
For more information circle **49** on inquiry card.

"MITE" 73

Announcing the First Item in Our New Line of Control Instruments.



The name "MITE" was selected for two reasons:
One, its miniature size,
and two, it, like "The widow's mite" *(Mark 12:41-44)*
though small, was very important to the One for Whom it was intended

The "MITE-73" is a monitor instrument designed to trip when a pneumatic signal violates its minimum or maximum* setting. It remains tripped after the signal is restored to normal limits until manually reset, either locally or remotely. When in service "MITE-73" will relay the input signal "A" to either one or both ports "B" & "C". (Either "B" or "C" must be plugged if not required.)

"MITE-73" is available in anodized aluminum, brass or 18-8 stainless steel.

Standard maximum pressure range 250 P.S.I., minimum trip adjustable 1-100 P.S.I.

From the above graphic description you will note the "MITE-73" has, like the common safety pin, many applications.

*If desirable to have the "MITE-73" trip on a maximum setting, tee off from A to D with a relief valve in the loop and set trip pressure desired.

REPRESENTATIVES IN PRINCIPAL CITIES

Write us for complete technical information, or for the address of our representative in your area.

GEORGE W. DAHL COMPANY, INC. 86 TUPELO STREET, BRISTOL, R. I.

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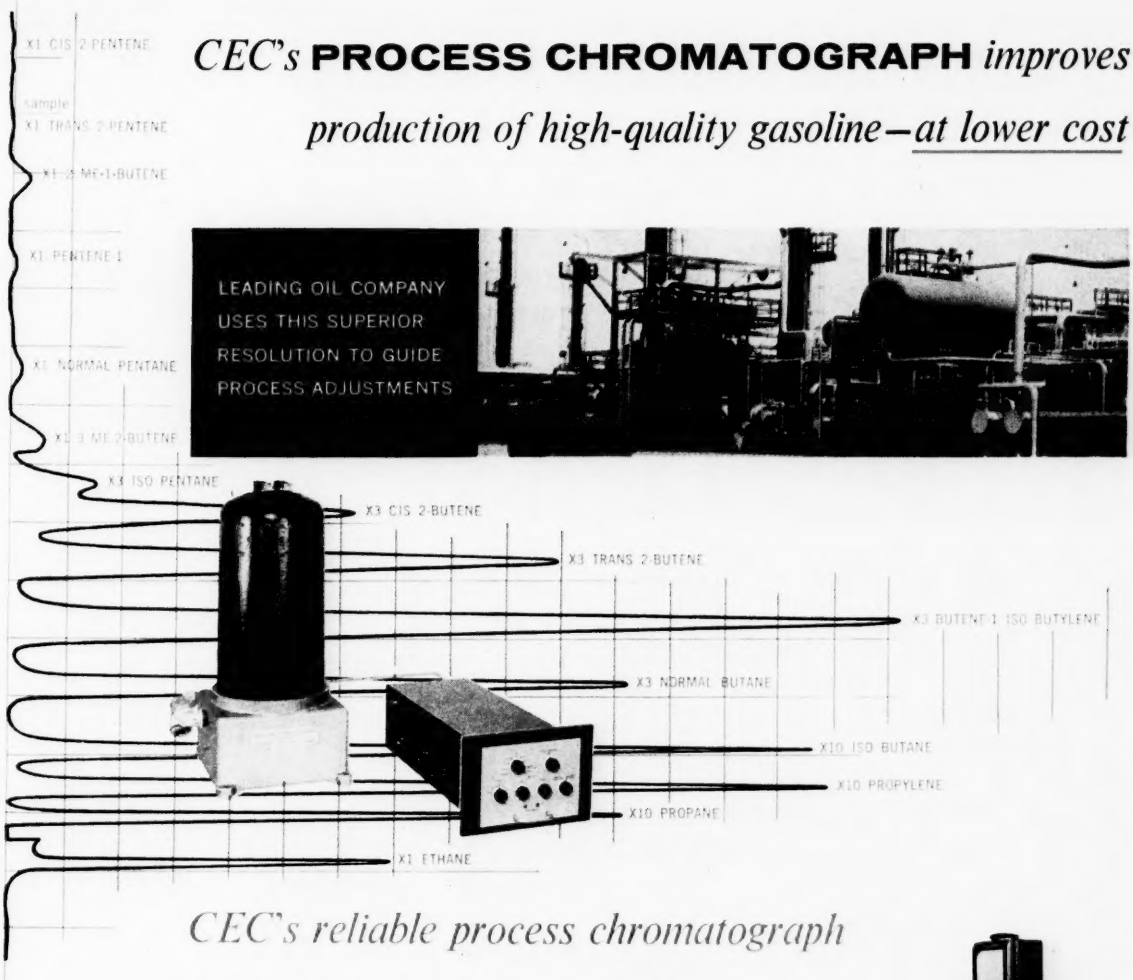
CEC's **PROCESS CHROMATOGRAPH** *improves production of high-quality gasoline—at lower cost*



LEADING OIL COMPANY USES THIS SUPERIOR RESOLUTION TO GUIDE PROCESS ADJUSTMENTS

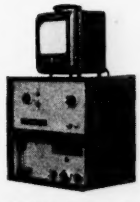
CEC's reliable process chromatograph

A major refiner reports improved quality control with their CEC 26-202 Chromatograph which is used in continuous monitoring of a depropanizer column. Rapid instrument response takes the guesswork out of process adjustment, helps produce higher-quality gasoline at lower costs.

For automatic, continuous remote-control monitoring and for the recording of multiple streams, no instrument can surpass the 26-202's simplicity, precise reproducibility, and precise regulation.

Sample volumes are reproducible to better than ± 0.5%, temperatures are controlled to less than 1° F.

This completely transistorized system provides *trouble-free, continuous service.* The Analyzer unit meets specifications for installation in Class I, Group D, Division 1 hazardous locations. The Control unit can be located at least 500 feet from the Analyzer. *Contact your nearest CEC Field Office or write for Bulletin CEC 1836-X29.*



. . . and for the laboratory

CEC's versatile 26-201A Laboratory Chromatograph guarantees speed and superior reproducibility. Easily operated by untrained help, the 26-201A features an exclusive Thermostatted Pre-Cut Column which reduces complex analysis time to minutes. Other exclusives are a capillary high-pressure sampling accessory and a heated sample vaporizer which assures reproducibility of better than ± 0.5% with sensitivity in parts-per-million. *Contact your CEC Field Office, or write for Bulletin CEC 1831A-X11*

NO MATTER WHAT YOUR PROBLEMS ARE

Simply state your needs. CEC's Application and System Engineers are available to design and install complete systems for any application. *Contact your CEC Field Office.*

Analytical & Control Instrument Division

Consolidated Electrodynamics

300 North Sierra Madre Villa, Pasadena, California

OFFICES IN PRINCIPAL CITIES THROUGHOUT THE WORLD

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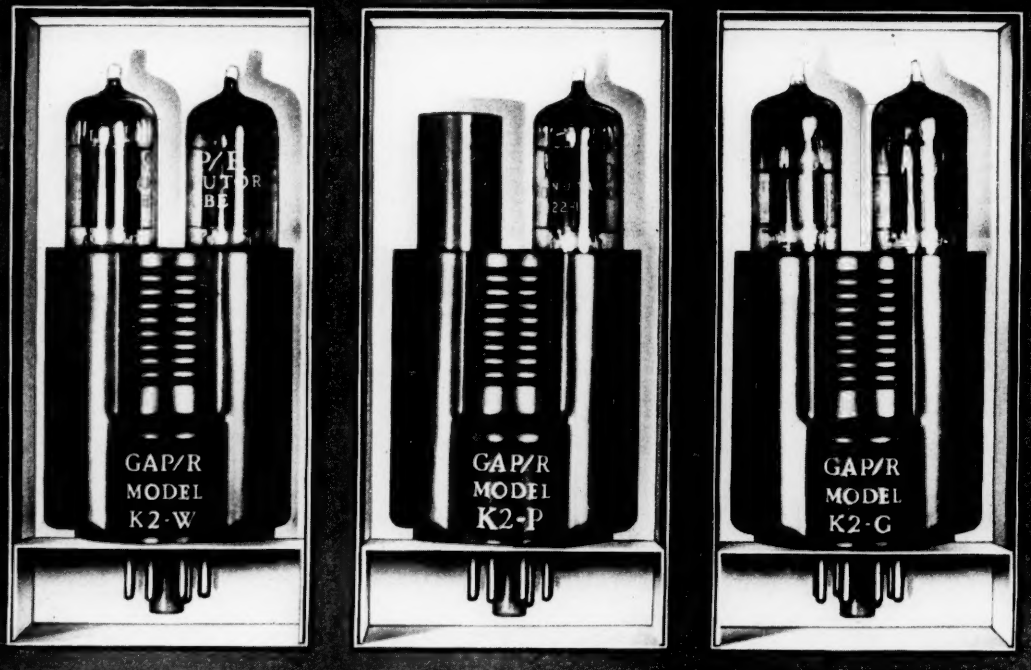
PLUG FOR ANALOG



FAST DC AMPLIFIER: Model K2-W is an efficient and foolproof high-gain operational unit for all feedback computations, fast and slow. A number of special varieties are also in quantity production. **($24.00)**

SLOW DC AMPLIFIER: Model K2-P offers long-term sub-millivolt stability, either by itself or in tandem with the K2-W. High-impedance chopper-modulated input. Filtered output to drive balancing grid or follower. **($60.00)**

SERRASSOID GENERATOR: Model K2-G produces a fixed triangular wave of 100 V peak-peak, at 500 kcps. Use it for quadratic rounding in diode networks, and for many other non-linear recreations. **($29.00)**

PHILBRICK uses these octal plug-in modules, and many others like them in their standard computing instruments. They are tried and true, compact, convenient, and economical. You too can find profit and happiness with their help . . . . . *All K2 Plug-ins run on plus and minus 300 VDC and 6.3 VAC. Socket wiring is simple and standardized. Write for freely given opinions on your application.*

The analog way is the model way . . . . . GEORGE A. **PHILBRICK** RESEARCHES, INC.

228 Congress St., Boston 10, Massachusetts

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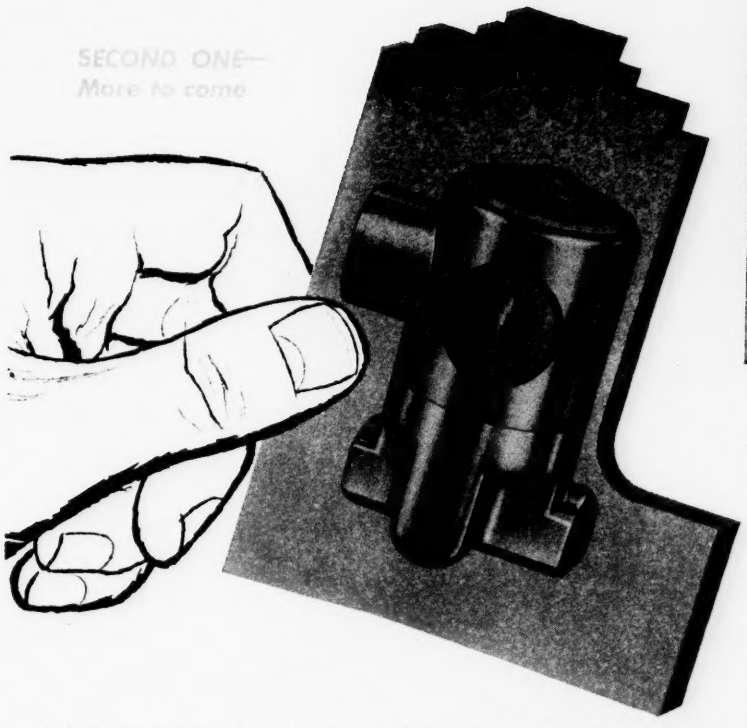
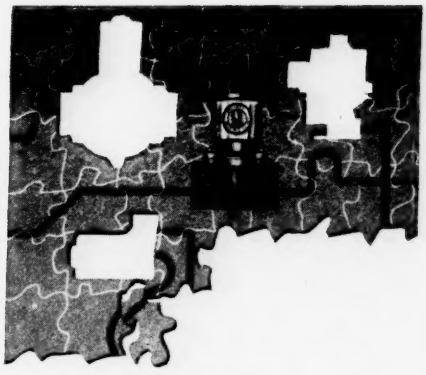




SKINNER'S NEW 2-WAY VALVE OFFERS

big capacity — high pressure

Here's the second new line of valves designed to answer your control "puzzles." This new line, called the R Series, is a two-way, pilot-operated piston valve with ¼" orifice and ¼" NPT. It is available normally open or normally closed and operates on a pressure differential of 5 to 200 PSI. This new R Series also includes an Explosionproof line in normally open and normally closed construction. A normally closed version will be available soon to operate on pressures up to 1000 PSI.

This new R Series uses the famous Skinner V5 Operator and will control air, water, oil and semi-corrosive media. The normally open version can, on request, be supplied with pilot exhaust piped to body outlet port.

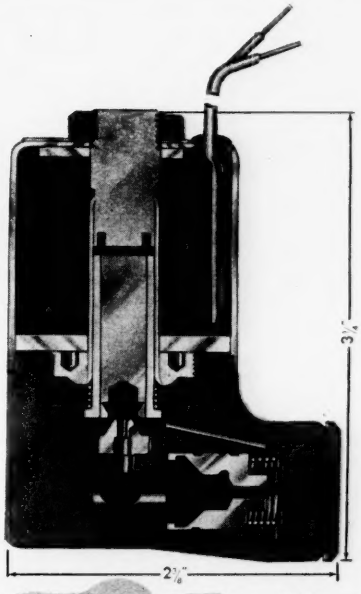
A wide selection of coils—high-temperature, waterproof and standard—for common AC and DC voltages is available, and there is choice of electrical connections such as Automotive Terminals, Grommet and Conduit.

The temperature range of this new line is −65° to 180°F Ambient, and −65° to 150°F Media. It is light in weight—only 1¼ pounds—and can be mounted directly to the line by means of the ¼" NPT. Distance between ports is 2 inches.

For complete information about this new line of Skinner valves, please contact our Representative or Distributor near you—you'll find him listed in the Yellow Pages. Or write us at the address below, Dept. 416

CONSIDER THESE OUTSTANDING FEATURES...

- Internal Parts—Stainless steel—give long, trouble-free service
- Coil—Continuous duty—10 watts max.—UL-approved
- Body—Forged brass—dense metal structure
- Mounting—Direct-line—can be serviced without removal from the line
- Options—Explosionproof, Manual Override, Electrical



SKINNER ELECTRIC VALVES

THE CREST OF QUALITY

SKINNER ELECTRIC VALVE DIVISION

NEW BRITAIN CONNECTICUT

105 EDGEWOOD AVENUE

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CRESCENT

POLYETHYLENE MULTITUBE

Special Types of Cabled Instrument Tubing To Meet Your Specific Need

These types employ HIGH MODULUS, high density polyethylene tubes made from new low pressure process polyethylene. Four to nineteen tubes of 1/4" OD are SPIRALLY CABLED together under heavy protective coverings which are designed to meet the unusually severe installation requirements with lowest cost.

TYPE XPT-U

Underground and General Purpose Type

Designed for direct earth burial or use in underground conduit and for above ground where subject to moderate mechanical abuse. Tubing is protected by a thick, tough polyvinyl chloride (PVC) sheath resistant to impact, corrosion and flame.

TYPE XPT-F

Flash Fire Resistant Type

A thick PVC sheath, heavy asbestos braid and overall PVC sheath over the tubing assembly provides several minutes of time delay for shutdown in the event of a flash fire. This construction also gives adequate protection from welding and cutting metal splash.

TYPE XPT-FA

Flash Fire Resistant—Armored Type

For complete mechanical protection, the tubing, thick PVC sheath and heavy asbestos braid are covered by an interlocked, galvanized steel armor. Designed for dry locations, type XPT-FA also gives several minutes of time delay in the event of a flash fire.

Send for BULLETIN with complete information.

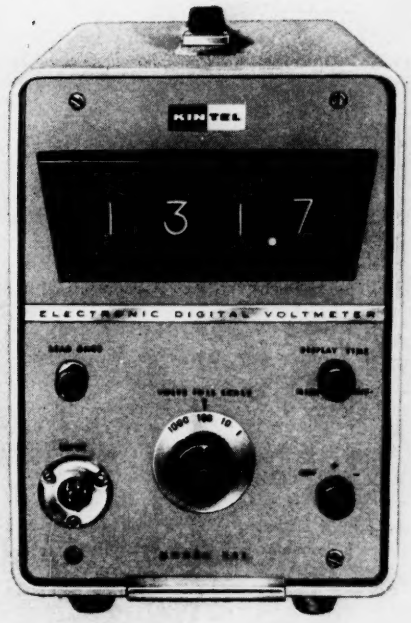
CRESCENT INSULATED WIRE & CABLE CO.

Trenton 5, New Jersey

For more information circle **54** on inquiry card.

ALL-ELECTRONIC DIGITAL VOLTMETER...ONLY $960

MEASURE
MILLIVOLT TO
KILOVOLT WITH
0.1% ACCURACY



Here at last is a portable all-electronic digital voltmeter that measures DC voltages from .001 to 1000 volts with 0.1% accuracy. In less than 1/10 of a second the measured voltage is presented in clear numerical form on a digital in-line readout that even unskilled personnel can read quickly and accurately, with little possibility of error. *Direct* voltage measurement by successive approximation provides accuracy and sensitivity previously obtainable only in the delicate, complex and expensive instruments. Extremely stable operation – continuous calibration against an internal reference.

The low price of the Model 801 allows you to put one on every bench. Its accuracy and reliability are assured by KIN TEL's years of design and manufacturing experience . . . experience gained in the manufacture of more than 10,000 precision electronic instruments.

BRIEF SPECIFICATIONS (model 801)

Ranges.....0.000 to 1.599; 00.00 to 15.99; 000.0 to 159.9; 0000 to 1000 volts (manual ranging and polarity)
Accuracy.....0.1% of full scale
Readout.....4 digits plus decimal point
Input Impedance.....20,000 ohms per volt*
Conversion Rate.....10 per second
Conversion Time.....approximately 70 milliseconds
Display Time.....Adjustable from approximately .1 second to infinity (plus push-button *read once* control)
Dimensions.....11" high x 7½" wide x 20" deep
Power Requirements.....105 to 125 volts, 60 cycle AC, 180 watts

*The Model 802 provides 10 megohms input impedance. Price $1190. In other special models the binary coded decimal and decimal outputs are externally available to permit use as an analog to digital converter.

5725 Kearny Villa Road, San Diego 11, California. Phone BRowning 7-6700

KINTEL
A Division of Cohu Electronics Inc.

Representatives in all major cities. Write today for demonstration or literature.

For more information circle **55** on inquiry card.

Simplify control problems...

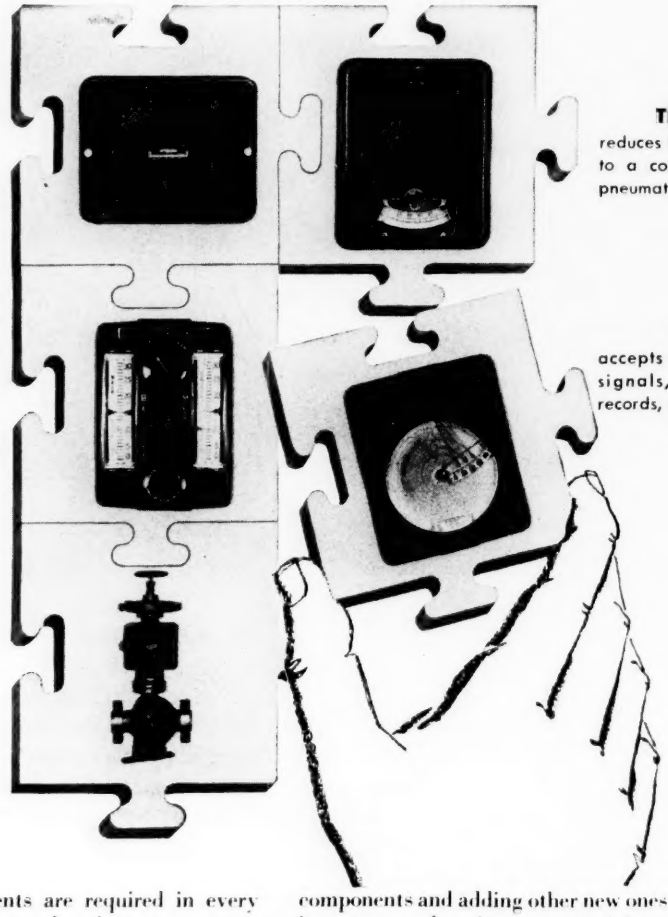
with the Bailey Building Block Method

Control problems are greatly simplified when you attack them using the Bailey Building Block Method. In a nutshell, the method consists of using standard components that fit together like building blocks. Virtually any control requirement can be handled by selecting standard components. Here are the parts you use and the functions they perform.

CONTROL RELAY
takes signals from the transmitter and computes corrective action in terms of pneumatic signals.

SELECTOR STATION
gives operator choice of hand or automatic control including set-point or bias adjustments.

POWER UNIT
is the "muscle" of the system. It performs whatever precise mechanical action is necessary to achieve control.



TRANSMITTER
reduces the measured variable to a common denominator, a pneumatic or electric signal.

RECEIVER
accepts pneumatic or electric signals, indicates and/or records, measurements.

Not all these components are required in every control system. You buy only what *your* system needs. When you change processes or add more automatic control, you can add additional standard components. Sometimes you may want to build a whole new system, re-using some of the existing components and adding other new ones. Spare parts inventory and maintenance training are reduced.

Hear the complete story of the Bailey Building Block System. Find how it can solve your control problems. See your Bailey Engineer or write for more information. G44-1

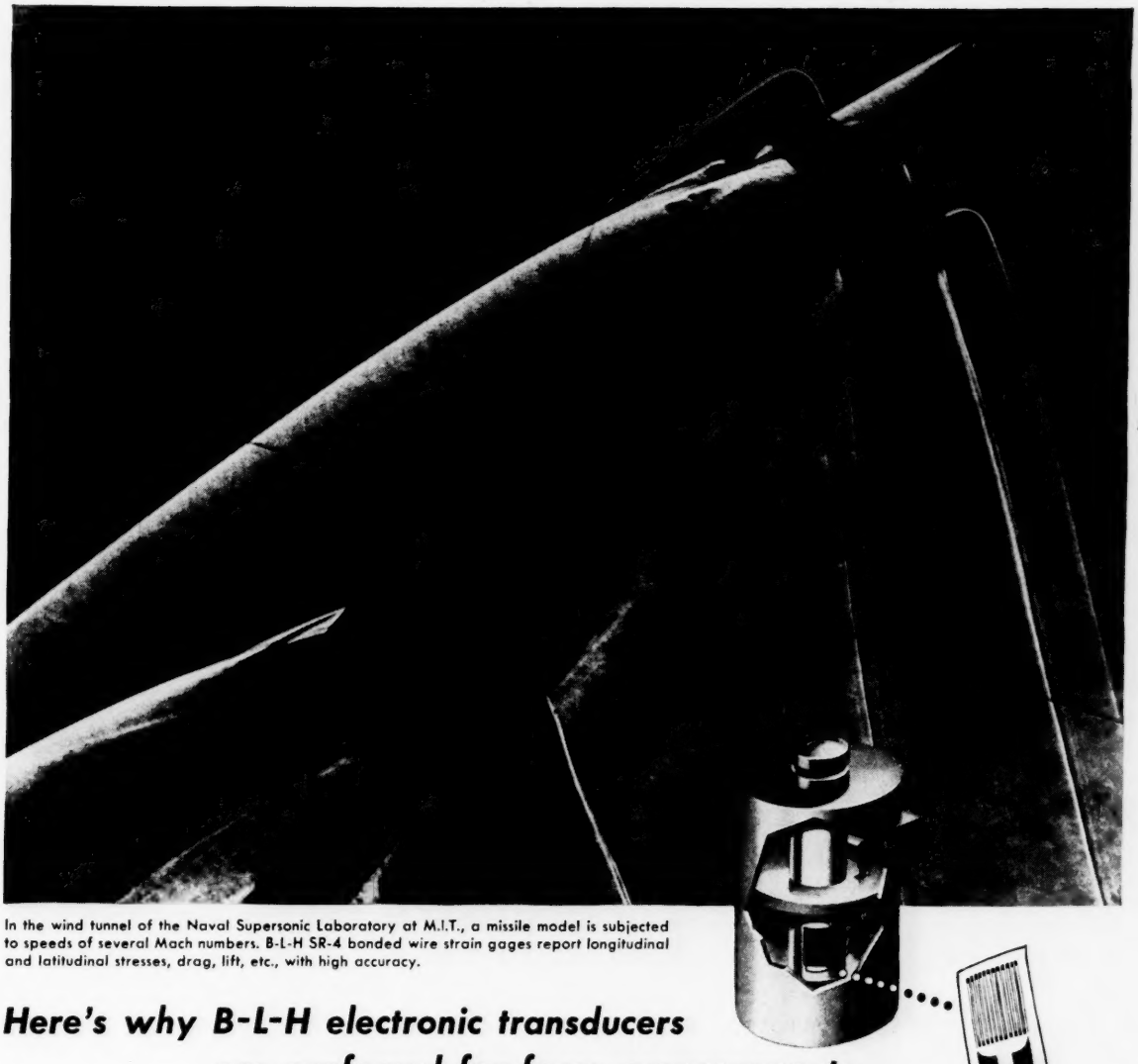
BAILEY METER COMPANY
1041 IVANHOE ROAD, CLEVELAND 10, OHIO
In Canada—Bailey Meter Company Limited, Montreal

BAILEY BUILDING BLOCK METHOD

RESULTS IN: FLEXIBILITY, SIMPLICITY, ECONOMY

BAILEY METERS

For more information circle **56** on inquiry card.

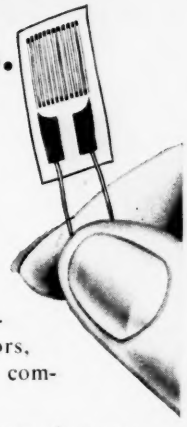


In the wind tunnel of the Naval Supersonic Laboratory at M.I.T., a missile model is subjected to speeds of several Mach numbers. B-L-H SR-4 bonded wire strain gages report longitudinal and latitudinal stresses, drag, lift, etc., with high accuracy.

Here's why B-L-H electronic transducers are preferred for force measurements

There is an easy way to measure accurately any forces involving tension or compression, torque, etc. B-L-H SR-4® electronic transducers are compact, highly responsive, and extremely durable. Stock units offer lasting accuracy of ±1/10% and repeatability of ±1/20%. With appropriate instrumentation, they can determine center of gravity, weigh loads at rest or in motion, control batch and continuous processes, and record all data required. The type and number of applications are virtually unlimited.

The heart of every B-L-H transducer is its SR-4 bonded wire strain gages. They are bonded to a metal element in the transducer and approximately 10 milliamperes is fed through them. They receive the same strains as the transducer when a force is applied. Their electrical resistance changes in linear relationship with strain. Voltage output can be calibrated directly in terms of load—or fed into any common types of instrumentation, such as dial indicators, graphic recorders, digital printers, computers, etc.



For more information on B-L-H electronic transducers—load cells, pressure cells or torque meters—ask to have a B-L-H man call on you or write to Dept. 7-F for a copy of Bulletin 4300.

BALDWIN · LIMA · HAMILTON

Electronics & Instrumentation Division

Waltham, Mass.

SR-4® strain gages • Transducers • Testing machines

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For more information circle **57** on inquiry card.

FREQUENCY STANDARDS

*3⅛" high
400 - 1000 cy.

PRECISION FORK UNIT
TYPE 50

Size 1" dia. x 3¾" H. Wght., 4 oz.*

Frequencies: 240 to 1000 cycles
Accuracies:—
Type 50 (±.02% at —65° to 85°C)
Type R50 (±.002% at 15° to 35°C)
Double triode and 5 pigtail parts required
Input, Tube heater voltage and B voltage
Output, approx. 5V into 200,000 ohms

FREQUENCY STANDARD
TYPE 50L

Size 3¾" x 4½" x 5½" High
Weight, 2 lbs.

Frequencies: 50, 60, 75 or 100 cycles
Accuracies:—
Type 50L (±.02% at —65° to 85°C)
Type R50L (±.002% at 15° to 35°C)
Output, 3V into 200,000 ohms
Input, 150 to 300V, B (6V at .6 amps.)

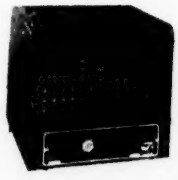
*3½" high
400 to 500 cy.
optional

PRECISION FORK UNIT
TYPE 2003

Size 1½" dia. x 4½" H. Wght. 8 oz.*

Frequencies: 200 to 4000 cycles
Accuracies:—
Type 2003 (±.02% at —65° to 85°C)
Type R2003 (±.002% at 15° to 35°C)
Type W2003 (±.005% at —65° to 85°C)
Double triode and 5 pigtail parts required
Input and output same as Type 50, above

FREQUENCY STANDARD
TYPE 2005

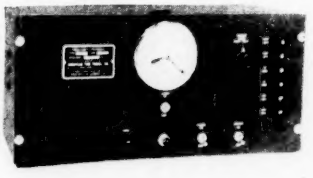


Size, 8" x 8" x 7¼" High
Weight, 14 lbs.

Frequencies: 50 to 400 cycles
(Specify)
Accuracy: ±.001% from 20° to 30°C
Output, 10 Watts at 115 Volts
Input, 115V. (50 to 400 cycles)

FREQUENCY STANDARD *NEW*
TYPE 2007-6
TRANSISTORIZED, Silicon Type
Size 1½" dia. x 3½" H. Wght. 7 ozs.
Frequencies: 400 — 500 or 1000 cycles
Accuracies:
2007-6 (± .02% at —50° to +85°C)
R2007-6 (±.002% at +15° to +35°C)
W2007-6 (±.005% at —65° to +125°C)
Input: 10 to 30 Volts, D. C., at 6 ma.
Output: Multitap, 75 to 100,000 ohms

FREQUENCY STANDARD
TYPE 2121A



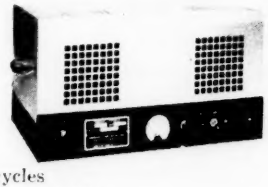
Size
8¾" x 19" panel
Weight, 25 lbs.
Output: 115V
60 cycles, 10 Watt
Accuracy:
±.001% from 20° to 30°C
Input, 115V (50 to 400 cycles)

FREQUENCY STANDARD
TYPE 2001-2

Size 3¾" x 4½" x 6" H., Wght. 26 oz.

Frequencies: 200 to 3000 cycles
Accuracy: ±.001% at 20° to 30°C
Output: 5V. at 250,000 ohms
Input: Heater voltage, 6.3 - 12 - 28
B voltage, 100 to 300 V., at 5 to 10 ma.

FREQUENCY STANDARD
TYPE 2111C



Size, with cover
10" x 17" x 9" H.
Panel model
10" x 19" x 8¾" H.
Weight, 25 lbs.
Frequencies: 50 to 1000 cycles
Accuracy: (±.002% at 15° to 35°C)
Output: 115V, 75W. Input: 115V, 50 to 75 cycles.

ACCESSORY UNITS
for TYPE 2001-2

L—For low frequencies
multi-vibrator type, 40-200 cy.
D—For low frequencies
counter type, 40-200 cy.
H—For high freqs, up to 20 KC.
M—Power Amplifier, 2W output.
P—Power supply.

This organization makes frequency standards within a range of 30 to 30,000 cycles. They are used extensively by aviation, industry, government departments, armed forces—where maximum accuracy and durability are required.

WHEN REQUESTING INFORMATION
PLEASE SPECIFY TYPE NUMBER

American Time Products, Inc.

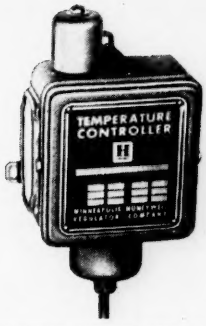
Telephone: PLaza 7-1430

Watch Master
Timing Systems

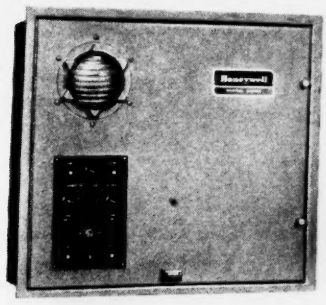
580 Fifth Ave., New York 36, N. Y.

For more information circle 58 on inquiry card.

PRESSURE CONTROLLERS for high or low-limit cutoff or signalling, or for control of pressure and vacuum in many ranges from 0 to 1000 psi.

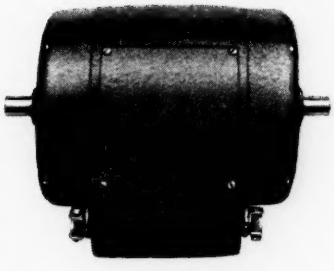


REMOTE BULB TEMPERATURE CONTROLLERS for high or low-limit cutoff . . . signalling . . . and automatic on-off, two-position, floating or proportional control with electrically or pneumatically operated valves, dampers, refrigeration units and similar equipment.



***PROTECTOGLO* FLAME SAFEGUARDS** instantly detect flame failure in gas or oil fired burners, and immediately shut off fuel supply, sound an alarm, and perform other functions to guard against explosion hazards.

Add low-cost automation ...with Honeywell industrial controls



INDUSTRIAL MOTORS for electrical operation of valves, dampers and auxiliary switches.

ALARM SILENCING RELAYS permit an alarm to be silenced, and light an integral red light until an unsafe condition has been corrected. Relay automatically resets the alarm when safe conditions are restored.

You don't have to spend a lot of money for dependable automatic controls. Like many manufacturers, you can use various Honeywell industrial controls as the efficient, low-cost means of automating your equipment . . . improving performance . . . increasing safety. And, you can use these inexpensive controls to save time, money and space by extending automation in your plant or process.

There are more than 9000 standard types of Honeywell controls to handle temperature, pressure, liquid level and humidity—for control, switching or safety functions. There are electric, electronic and pneumatic types.

Though they're low in cost, these controls are top-quality, reliable devices. If there's not already a standard control for your particular application, Honeywell can design and build one for you.

Your nearby Honeywell field engineer will be glad to discuss your control requirements. Call him today . . . he's as near as your phone.

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H MONITROLLER *First in Controls*

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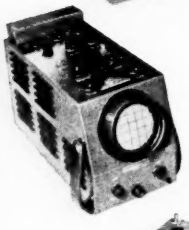
Portable—Dependable—Economical

Rugged, highly portable "pocket-size" oscilloscopes that can be carried to the job in one hand without sacrifice of the high precision that qualifies them for laboratory use. For field, production line, or laboratory, they save labor, space, money! POCKETSCOPES combine high electrical performance, reliability and low cost.

S-11-A INDUSTRIAL POCKETSCOPE

Features DC amplifier, repetitive sweeps and circuit ground isolation . . . for DC and low frequency work.

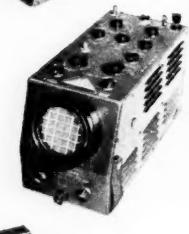
5" x 7" x 11" . . . 8¾ lbs. **$149.50**



S-14-A HI-GAIN POCKETSCOPE

Identical vertical and horizontal amplifiers, sensitivity to 10 mv; trigger or repetitive sweeps from ½ cps. to 50 KC; ± sync; calibrated voltages.

6" x 7" x 12" . . . 12¾ lbs. **$249.00**



S-14-B WIDE BAND POCKETSCOPE

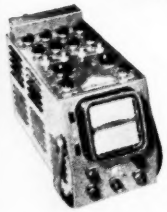
Similar to S-14-A except lower sensitivity, greater bandwidth. Triggered or repetitive sweeps from ½ cps to 50 KC;

6" x 7" x 12" . . . 14 lbs. **$239.00**

S-14-C COMPUTER POCKETSCOPE

DC type signal amplifier bandpass more than meets need of most computer service . . . calibrated trigger sweeps; 5X trace expansion; excellent stability.

6" x 7" x 12" . . . 16 lbs. **$289.00**



S-15-A TWIN-TUBE POCKETSCOPE

A unique approach to dual trace oscilloscopy . . . two rectangular cathode ray tubes, common internal trigger or repetitive sweep generator . . . DC type signal amplifiers sensitivity to 10 mv.

6" x 7" x 12" . . . 16¼ lbs. **$399.00**

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PULSESCOPE*
RAKSCOPE*
RAYONIC* Cathode Ray Tubes
and Other Associated Equipment

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MEMO... Write for details today!

WATERMAN PRODUCTS

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BOOK Reviews

Automation and Management, by James R. Bright. 1958. Harvard Business School. Division of Research. Instruments Publishing Co., 845 Ridge Ave., Pgh. 12, Pa. 280 + XV pages + 16 pages of photographs. 13 appendices. $10. $11\frac{1}{4}$ in. Book is divided into three parts in which the author describes (1) the Nature of Automatic Manufacturing. (2) Experiences with Mechanization, and (3) Critical Areas of Automation.

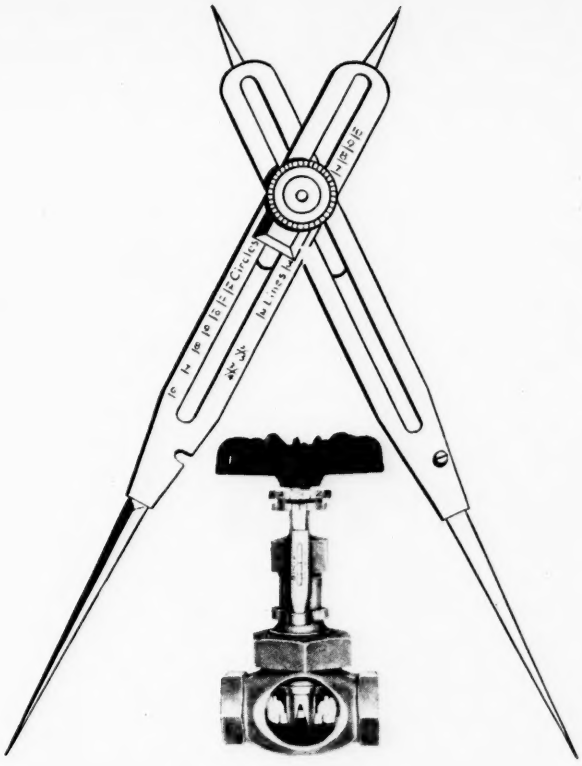
Industrial Electronics Circuits, by R. Kretzmann (translated from German by D. J. Mitchell). 194 + VIII pages. 1957. Philosophical Library, New York 16, N. Y. $10. 9 in. cloth binding. Includes nearly 200 circuits. Functions of various circuit elements are described.

Industrial Control Circuits, by Sidney Platt. 194 + VI pages. 1958 John F. Rider, New York 11, N. Y., $3.90. $8\frac{1}{2}$ in. Uses specific industrial applications to describe problems of industrial control.

International Dictionary of Physics and Electronics, edited by Walter C. Michels (senior editor) and 14 contributing editors. 1956. Van Nostrand, Princeton, N. J. 1004 + XVIII pages. $22.50 $10\frac{1}{4}$ in. Over 300 illustrations. Includes terms from sixteen major subject divisions, also descriptions of instruments, apparatus and their components.

Engineering Formulas and Tables, 1958. Lefax Publishers, Philadelphia 7, Pa. $6\frac{3}{4}$" x $3\frac{3}{4}$". Loose-leaf binding. 396 pages. $4.75. Contains basic formulae, design data, and tables for civil, mechanical, and electrical engineers in 12 sections with tabbed indexes.

Basic Motion Timestudy, by Gerald B. Bailey and Ralph Presgrave. 1958. McGraw-Hill Book Co., New York 36, N.Y. 195p. $5. $9\frac{1}{4}$ in. Built around a unit called "basic motion" for which the authors claim certain unique advantages. Tables give time-study values expressed in ten-thousandths of a minute.



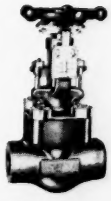
PROPORTIONER

controls flow to save for you

The V-port disc in all Hancock "Flocontrol" Valves insures proportional flow throughout the entire lift of the stem. They are valves that help you achieve uniform product quality through closer control, save steam and fuel on process work, and cut maintenance costs.

"3 in 1" valve design combines variable orifice with shut-off and micrometer dial and pointer. The valve opening can be set within 1/10 turn of the handwheel —you can duplicate all settings easily, instantly. No shut-off valve required—flow is in a straight line, with separate shut-off seating surface located away from the V-ports.

Hancock "Flocontrol" Valves are available in Bronze and Steel to meet the most demanding services. Ask your industrial supply distributor for details.



Hancock "Flocontrol" valves assure positive pinpoint control—eliminate all guesswork.

MANNING MAXWELL & MOORE INC. MM&M TRADE MARK

HI-58

HANCOCK "FLOCONTROL" VALVES

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In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

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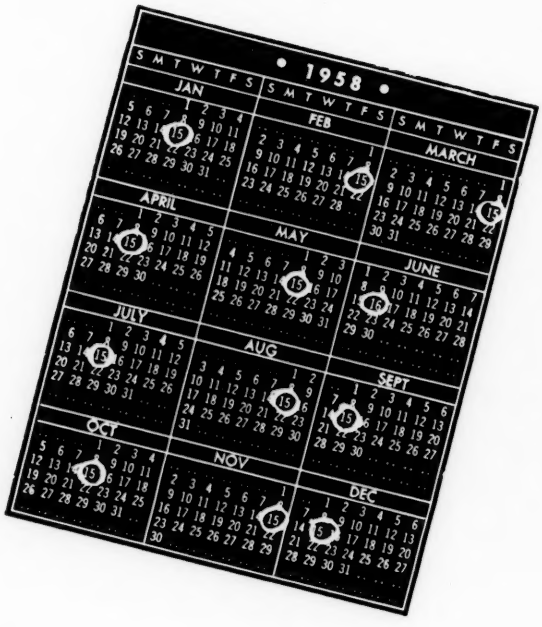

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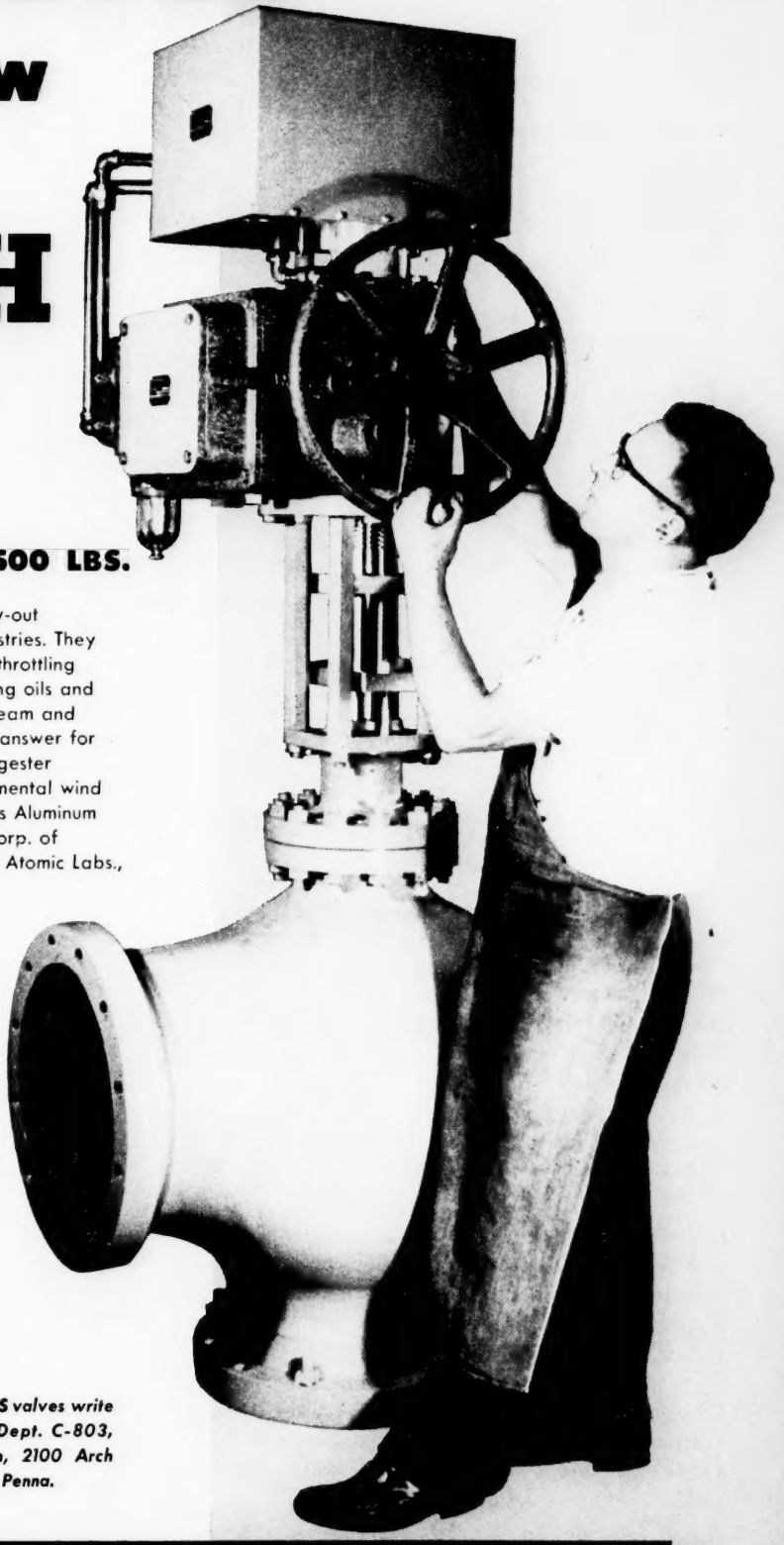
S VALVES

by CONOFLOW

TOUGH



SIZES TO 14"
PRESSURE RATINGS TO 2500 LBS.

S valves by Conoflow are on day-in, day-out service handling the tough jobs in many industries. They offer unmatched performance for automatic throttling control of erosive and corrosive slurries, coking oils and liquids, and high pressure pipe line gases, steam and water. **S** valves have proved to be the final answer for such services as alumina refining, pulp mill digester relief, boiler feed water control, and experimental wind tunnels. A few well-known users are: Reynolds Aluminum Co., U. S. Steel, Humble Oil Co., Aluminum Corp. of America, Texas Co., Redstone Arsenal, Knolls Atomic Labs., and Olin-Revere Metals Corp.

The difference is in the design...
The patented, single-seated **S** valve is of heavy, rugged construction throughout. Extra body wall thickness, streamlined contours and heavy stem guiding make the **S** valve especially suited for high pressure drops. Venturi seat ring and parabolic plug assure tight shut-off. Self-sealing bonnet is leakproof. Sizes 1" through 4" carry ASA ratings to 2500 lbs.; sizes 6" and 8" to 1500 lbs. ASA; sizes 10", 12" and 14" to 300 lbs. ASA.

For complete data on S valves write for Bulletin S-1 to Dept. C-803, Conoflow Corporation, 2100 Arch Street, Philadelphia 3, Penna.

Cono-Controls®

CONOFLOW CORPORATION

FOREMOST IN FINAL CONTROL ELEMENTS

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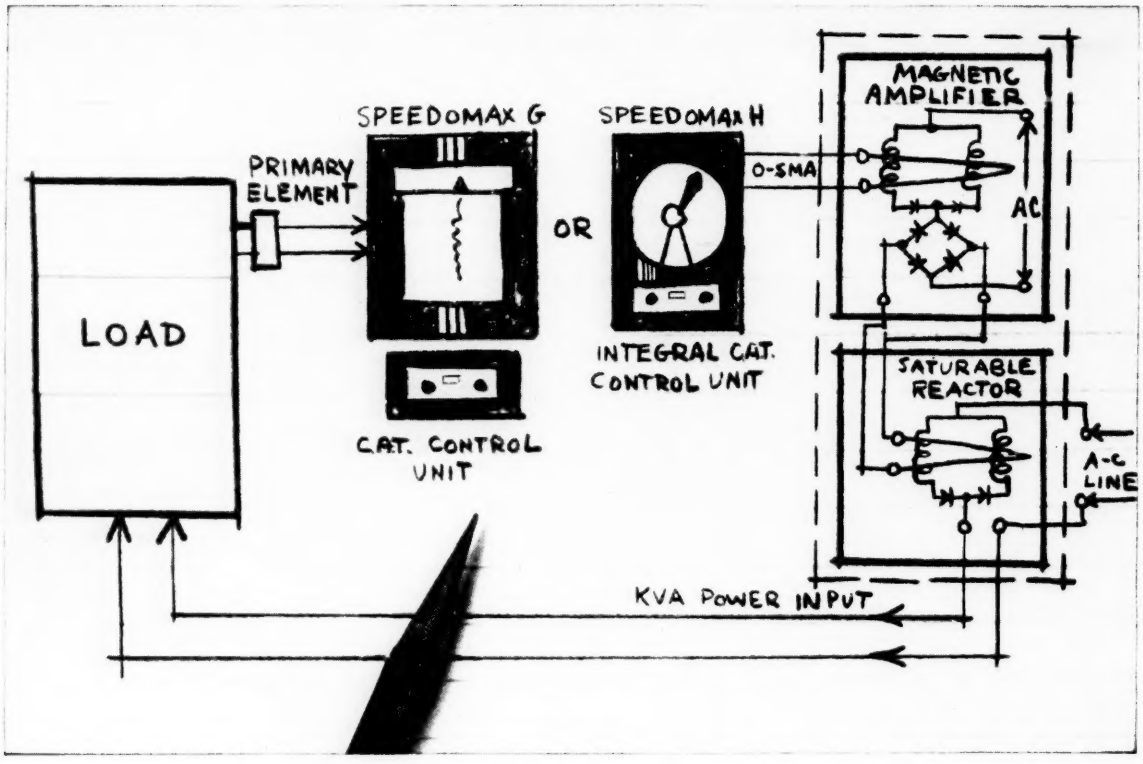

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GUEST EDITORIAL

Significant Science for Secondary Schools

M. Marcus Kiley

Deputy Superintendent of Schools
Springfield, Mass.

IT is generally conceded that the loftiest of educational objectives has to do with the spiritual transfiguration of man. The greatest thing about man is his ability to transcend himself, his ancestry and his environment and to become what he dreams of being. This is the first great objective of education.

The second most important objective is also a human one, and arises from the discovery that we do not have to go through life with the limited senses we were born to have. That is significant for science teachers in secondary schools.

When men realized that their sight might not always be as good as they would like or need, they made "long eyes" extending some distance, and they magnified so that man became aware of things sharing the world with him about which he never knew before. This new "sight" led to bacteriology, sterilization, refrigeration, sanitation and hygiene.

There is radioactivity in this room to which certain instruments will respond, but to which you and I cannot respond. There are many other activities that go on about us of which we would be unaware if we depended upon our unaided senses. These include pressures, temperatures, humidities, radiations of many sorts, and many microscopic and macroscopic phenomena.

Young people have at least five senses (they can see, they can hear, they can feel, they can taste, they can smell) and if somehow you had a program of instruction by which you proposed to use one *less* than their five native senses, which one would you take out? You would dare to take out any. But how many senses are you denying students when you fail to teach about instrumentation?

Science is significant in the secondary schools principally for two reasons—that out of it young people can equip themselves better than ever before for the remainder of their lives, and also obtain the best view of the future which anybody has to offer.

Now what to do about it? The problem before the science teacher in the secondary school is to concentrate on three projects which are his serious responsibility. The first is to see to it that his youngsters recognize that they *can* have better senses (instruments) to apply to the problems they face, and that they look for them and use them. Secondly, that they learn the business of transferring energy from supplies which are available to any other kind that they may need, and that they learn how to control energy in small and large amounts. The third responsibility is to offer for instruction those parts of science which will stand up under investigation as the *important parts*, deserving of the limited, irreplaceable time available for learning.

We tried to be scientific in revising our secondary-school course of study in light of these criteria. We made use of two references: (1) The Federal Security Agency, Office of Education Circular No. 308 (May, 1948), *The Major Principles of the Biological Sciences of Importance for General Education*, by Edgar Martin. (2) Circular No. 308, subnumber IV, *Major Principles of Physics, Chemistry, and Geology of Importance for General Education*, by Harold Wise, Edgar Martin and Philip Johnson.

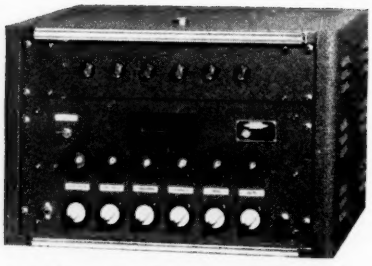
It was proposed to teach fify physical principles and fifty biological principles in the secondary schools. First we picked the principles. Second we picked the text. Then we made demonstration units. From these we made our bill of materials. Then we made audio-visual aids.

Then we wanted to know how well these were being taught. We secured a publication of 13,000 science questions for college purposes (issued last year by the Educational Testing Service) and picked 400 multiple-choice questions. A machine-scored test of 100 questions is being prepared. We propose (1) to limit our instructions to what is important, (2) to go about it three-dimensionally, (3) to use audio, visual and 3-dimensional aids to help, (4) to apply tests which are machine-scorable, standard and from high quality sources, and (5) to turn back to each teacher a statement in the form of item analysis of what actually has been taught so that re-teaching may redeem any low achievement.

Our major efforts are in the grades where general science is a common subject. The most general science today is the science of waves and particles. It is difficult to find any science that does not resolve into electron physics if followed far enough. Every branch of science is borrowing from *physics* for basic ideas and from *instruments* to improve observations.

Teaching in science should be more than a textbook acquaintance or a mere understanding of principles. Science pays its way in shops and foundries and gardens and hospitals, but seldom in classrooms. Our students should eventually know how to make what science calls upon them to produce in materials and equipment, particularly in better and better instruments. We, as school officials, should recognize instruments as new and nobler senses for the young human beings who come to school to us.

Presented at the Group Session on "What's New in the Content and Method of Teaching Science," American Association of School Administrators, 1958 Regional Convention, Cleveland, Ohio, March 31, 1958.



P-6 Electronic Counter of Post Machinery has "Nixie" cold-cathode readout (top), electromechanical totalizer (center) to indicate number of batches of preset count, plus glow-transfer "Dekatron" type readout (bottom).

A survey of the features of the three basic types of digital readout indicators.

Numerical Readout

DIGITAL READOUT is growing in importance. In addition to all basic counting and computing applications, it is common today to have pressures, temperatures, flows and other process variables monitored by direct digital readout. A host of analog-to-digital conversion devices are now available for such applications, as has been described in previous chapters of this series.

Indicators alone will be considered here: digital *printouts* will be considered in the future.

The basic factor in selection of a numerical readout device are:

1. Type of actuation or input.
2. Speed of operation.
3. Size of character as well as of readout units.
4. Type of readout (inline or vertical, flat-plane or stacked, decimal or binary-coded decimal, readability).
5. Flexibility (preset, reset, remote reading, and adaptability to control).
6. Life.
7. Cost.

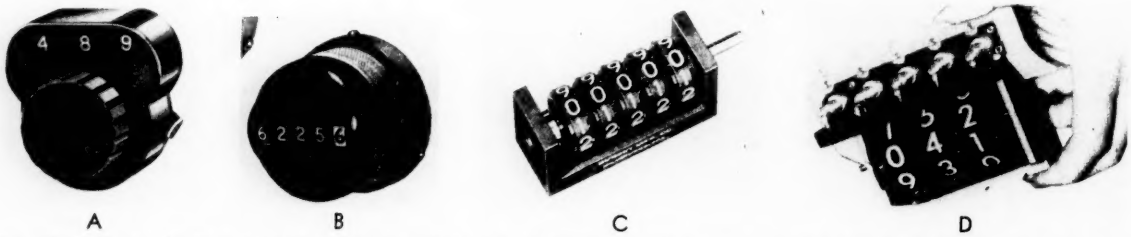
The basic types of indicators are:

1. *Counter wheel* or *belt*, in which characters on a wheel or belt are positioned in front of a window.
2. *Display-type* indicators in which lights, neon tubes, or luminous devices are used to light up a number, to project an image, or to form the number.
3. *Tube-type indicators* in which electron beams or cold-cathode tubes are used to form or to indicate the number.

Counter Wheel and Belt Types

Other than lighting a pilot light behind a numbered window, the wheel-type counting mechanism is the simplest digital readout indicator. Widely used for counting, such indicators are available in a wide variety of displays with preset and reset features, and with electrical outputs for remote parallel readout or control of machinery.

Basic actuators for wheel and belt type indicators are (1) *mechanical*—rods, levers, shaft rotation, etc.; (2) *electrical*—ac or dc pulses, or coded pulse signals; (3) *pneumatic or hydraulic* pulse signals.



A B C D

Fig. 28-1. Mechanically actuated readouts include the Beckman-Helipot "Digidial" (A); the Borg "Microdial" (B), the Durant "Productimeter" (C), and the Hycon (D).

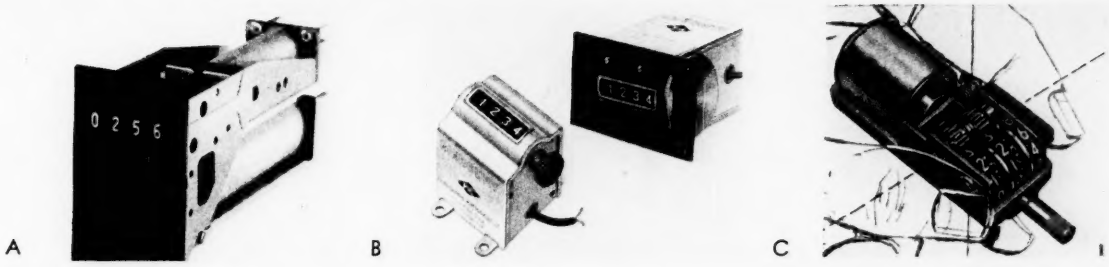


Fig. 28-2. Solenoid-actuated counters include the Landis & Gyr "Sodeco" impulse counters (A), the Production Instrument Company PIC units (B), and Veeder-Root counters (C).

The electromechanical types use either solenoids or motors to drive the counter wheels, and the motors can be commanded by synchro, commutator, or relays.

Fig. 28-2 shows typical solenoid-actuated readouts.

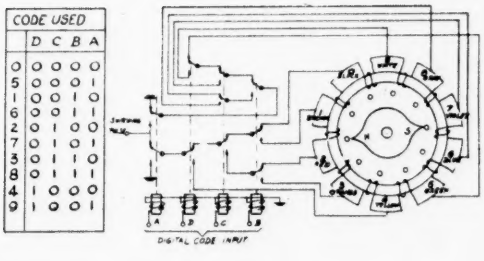
Fig. 28-3 shows a magnetically-actuated readout, and the 4-digit code used for positioning the ball-bearing-type wheel.

Fig. 28-4 shows a belt-type readout in which the characters are on a belt positioned by a motor that receives a 6-bit input signal. When input code does not match that of the internal commutator (with contacts on the radially coded disk) the motor is activated until the commutator equates the input. The six-bit code permits 72 characters (alpha-numeric) on belt; a 4-bit code is used for a similar 10-digit counter-wheel unit.

A basic use of digital readouts is in counters and digital voltmeters. The "data display rate" given in the following descriptions sometimes refer to the maximum counting rate of the counter, or to the maximum display rate at which voltmeter measurements can be made, and are so indicated. It should be kept in mind that the maximum data display rate of the indicator itself may be higher. For example, most electric display-type and tube-type indicators can be used at microsecond rates. The speed of the following mechanical readouts is limited by the gearing drive units. The mechanical action of the wheel limits the data display rate to about 400 counts/second (2500 rpm of a decade wheel). Average data display rate, however, is less than 100 counts/second.

The many features available include adaptability to telemetering, contact closures on each digit for digital control and switch readout applications, nonambiguous readout, various reset and preset techniques, readout in terms of dozens and grosses, and other features.

Fig. 28-3. Patwin "Magneline" counter features ball-bearing wheel and magnetic positioning in 0.5 second by 4-bit code.



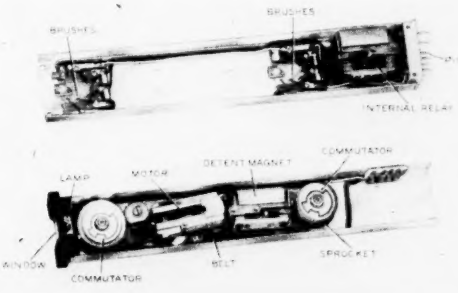
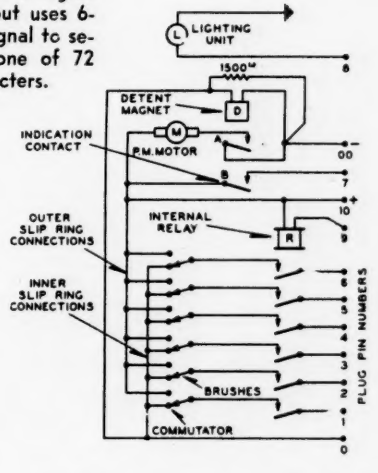


Fig. 28-4. Union Switch & Signal readout uses 6-bit signal to select one of 72 characters.



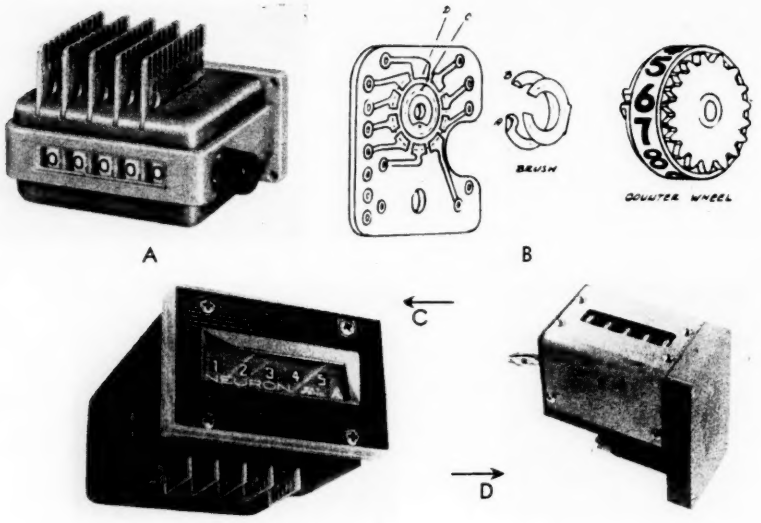


Fig. 28-5. Readouts with contacts for control include the Veeder-Root (A and B), the Autron Engineering "Neuron" unit (C), and the Digitran "Digidex." A 5-digit unit can provide 100,000 separate circuit arrangements.

A feature with important control implications is electrical readout via contacts on each wheel. Fig. 28-5 shows three typical digital readouts with contacts for remote readout or control.

Simple wheel-type mechanically actuated counters and readouts are available at prices as low as $4 per unit. Counters with potentiometric (proportional voltage) output and contact closures for control of machinery can cost from $120 to $800.

Display-Type Readouts

Display-type readouts use luminous devices (incandescent lamps, neon tubes, fluorescent materials) to develop the numeral either by directly forming the number, by lighting up an engraved panel, or by projecting an image. The basic advantages of the display type over the counter-wheel type are (1) larger character and (2) more rapid data display rate—above 1 million counts per second if necessary.

The speed and other advantages of the all-electric display-type readouts are causing rapid and wide acceptance. A common type uses cut-out numbers with a neon bulb behind each number; when the bulb is lit, the number stands out. Flip-flop chains can drive readouts at rates above 1 mc. This high speed combined with economy (about $30 per decade) make these units popular as decade counting units (DCU's).

Fig. 28-6 shows typical high-speed counting units using neon bulbs.

The disadvantage of this type—small size of character—is overcome in projection-type readouts (Fig. 28-7), in edge-lighted engraved-plastic readouts (Fig. 28-8), and in the readouts shown in Figs. 28-9 to 28-12.

The price of projected-image readout units begins at less than $15 per decade (or character).

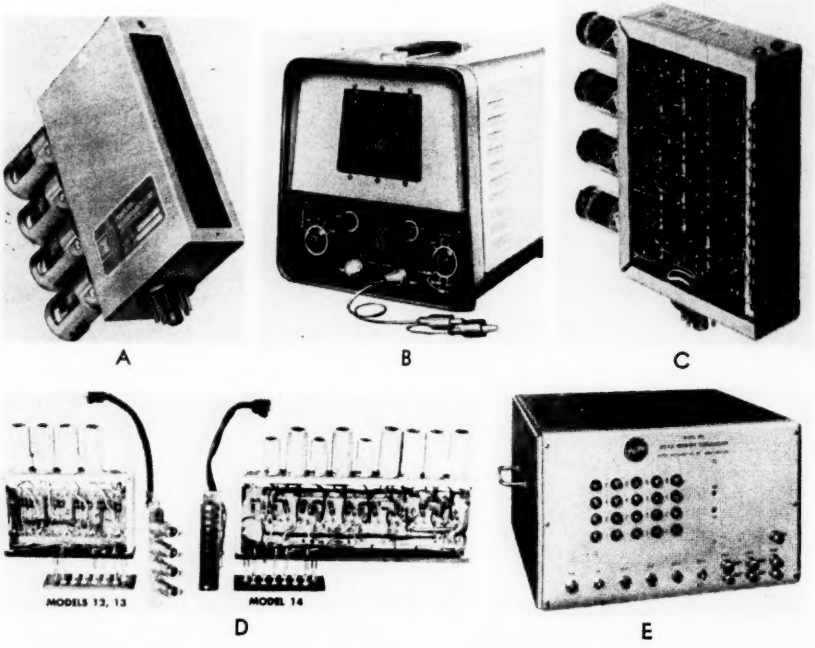


Fig. 28-6. High-speed DCU's using neon bulbs. A shows CMC readout; B shows small Franklin Electronics readout in a digital voltmeter; C shows the Hewlett-Packard counter; D shows 1-Mc Potter Instrument counter (Model 14) and slower speed Model 12; E shows Potter Instrument binary-coded decimal (1-2-4-8) readout.

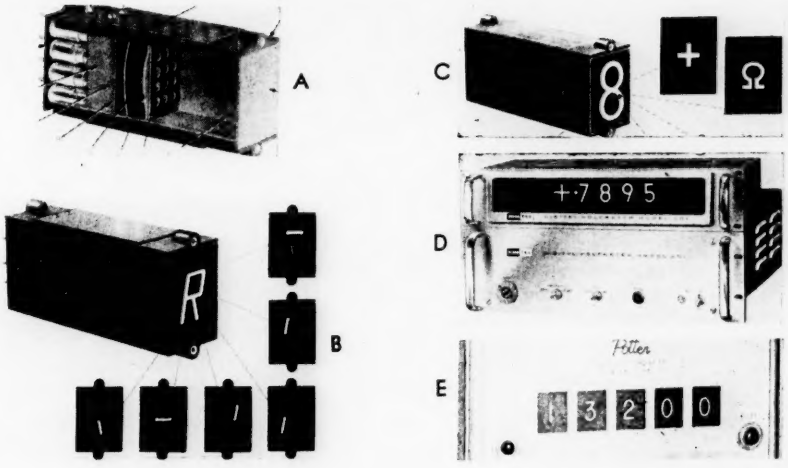


Fig. 28-7. Displays using projection technique. A shows the principle of the Industrial Electronic Engineers readout which forms character either by projecting straight line segments (B) or by projecting entire character (C). D shows the Kin-Tel projection type readout; E shows Potter Instrument projection-type unit.

Perhaps the most economic display is the pilot light with a number on the jewel. Costing only about $1 per character, it has the disadvantage that the number is fixed, rather than variable (Fig. 28-9).

As shown, other available display types include those which form the numerals by selecting bars, by using numbers of lights, and by several different projection techniques. Prices of the more elaborate of these displays reach $100 per decade ($700 for a 7-digit readout).

One of the most recent entries into the display-type readout field uses electroluminescent techniques to form the character by straight-line segments. Prices are about $100 per decade (Fig. 28-12).

Tube-Type Readouts

In tube-type readouts, either glowing cathodes (in gas tubes) or electron beams (in cathode-ray or beam-power tubes) are used to form or to indicate the number.

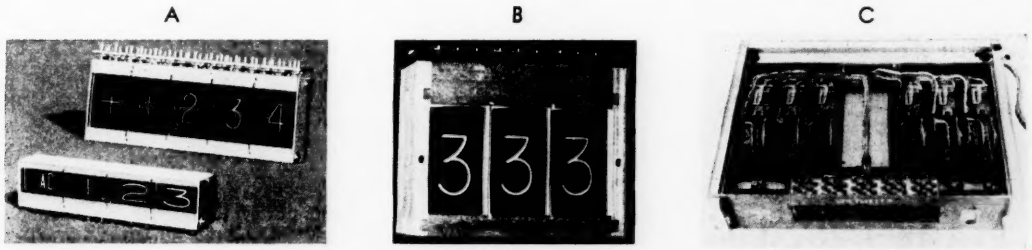


Fig. 28-8. Edge-lighted engraved-plastic displays include the Electro-Instruments (A), the Non-Linear Systems (B), and the Cubic Corp. (C)

Fig. 28-9. Dialight pilots.

Fig. 28-10. CMC readout forms number by selecting from 40 lamps per numeral.

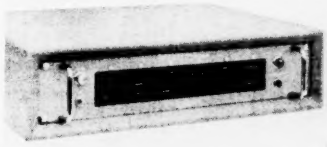


Fig. 28-11. Beckman-Berkeley indicator forms number by selecting up to 7 straight-line segments.

Fig. 28-12. Westinghouse "ELF" readout.

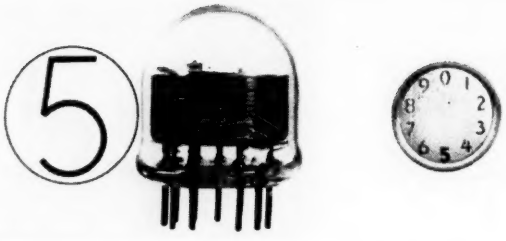


Fig. 28-13. Burroughs "Nixie" (left) and "Pixie" (right) use cold-cathode tubes.

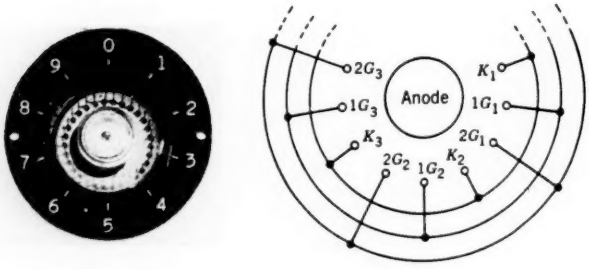
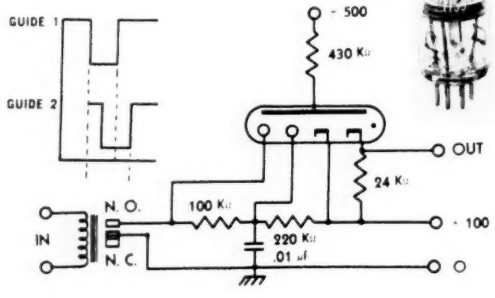
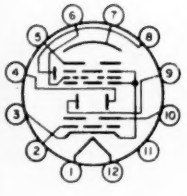


Fig. 28-14. Baird-Atomic "Dekatron" cold-cathode counting tube.

Fig. 28-15. Sylvania glow-transfer tube and driving circuit.





BASING CONNECTION PIN NO.	ELEMENT
1	HEATER
2	GRID NO. 1 (CONTROL GRID)
3	CATHODE AND GRIDS NO. 3 AND 5 (SUPPRESSOR GRIDS)
4	DEFLECTING ELECTRODE (D')
5	PLATE
6	GRID NO. 4 (SLOTTED ELECTRODE)
7	FLUORESCENT LAYER
8	RESET PLATE
9	DEFLECTING ELECTRODE (D)
10	GRID NO. 2 (ACCELERATING ELECTRODE)
11	INTERNALLY CONNECTED
12	HEATER

Fig. 28-16. Amperex E1T beam-power glow-spot readout.

A popular tube-type display is the cold-cathode gas-tube type in which the cathode glows when proper voltage is applied between the common anode and any one of ten integral cathodes. The cathode can be formed into a numeral, or it can be spot-shaped and located behind the number engraved on the face of the tube (Fig. 28-13). One million counts per second can be displayed.

Glow Transfer

The decade-counter glow-transfer tube (Figs. 28-14 and 28-15) is a gas-filled device employing 30 pin-like cathodes which surrounds a disc-shaped anode. The cathodes are identical physically but are electrically connected in three groups, called guide 1 buss, guide 2 buss, and output cathode buss. Conduction occurs in the tube between the anode and the most negative cathode pin, causing a glow on the tip of the pin which permits direct visual read-out, and electrical readout in the form of voltage developing across a cathode load.

In operation, a negative input pulse is applied to the guide 1 buss, which causes the glow to move from a cathode (the quiescent position) to the nearest guide 1 pin. Near the end of the first input pulse, a second input pulse is applied to guide 2, making it the most negative pin and causing the glow to shift there. Since the guide pins are normally positive with respect to the cathodes, removal of the input pulse from guide 2 causes the glow to move to the nearest cathode, thus completing one counting cycle.

Fig. 28-15 shows a typical driving circuit, using a contactor, for the Sylvania glow-transfer tube. Electronic circuit drives are also used. Note double driving pulse.

The glow-transfer tube can be used at rates up to 100,000 counts/second.

Beam Power

In the beam-power technique, the beam causes a spot to appear beside the number engraved on the face of the tube.

Beam is formed by beam-forming electrodes and is positioned by deflecting electrodes (Fig. 28-16). Beam current is 1 ma at 300 v on anode. A positive voltage pulse of 13.6 v (± 15%) deflects an electron beam through successive slots in an arrestor plate. Max rate is about 100,000 counts/sec.

Cathode-Ray-Tube Readouts

In the cathode-ray-tube technique, the number can be formed either by shaped masks within the cathode-ray tube or by imposing deflection and modulating signals on the tube by an external character generator. The basic advantage of the cathode-ray type presentation is ability to "write" many different characters of different sizes over a wide area (the face of the tube) and at high speed.

Cathode-ray-tube readouts find application as computer readout where their fast response is compatible

Fig. 28-17. DuMont character display tube.

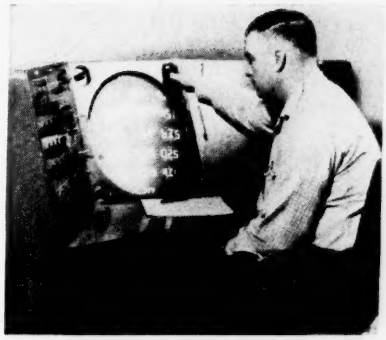


Fig. 28-18. American Machine & Foundry "Digitron."

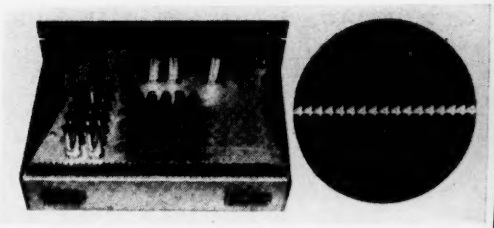


Fig. 28-19. Wang Laboratories character generator.

with the computer delivery speed. Another area where these tubes serve to advantage is in identifying objects in radar displays: time sharing permits both the radar picture and the character coding to appear on the same tube face.

Fig. 28-17 shows the DuMont character display tube, available with round or rectangular faceplate in all sizes from 5" to 19". Both electrostatic and magnetic deflection techniques are used, the former to scan a small area of the tube to form the character, the latter to position the character. Deflection signals are developed either by an external character generator or by a monoscope (target-type) cathode-ray tube in which the target is shaped into the desired characters. Up to 35,000 characters per second can be displayed.

In the "Digitron" (Fig. 28-18), characters are written by a programmed electron beam using straight or curved-line segments. A modified 19" CRT with elongated neck permits both electrostatic and electromagnetic deflection (the former to trace the symbol, the latter to position it). Up to 50,000 characters per second can be displayed; 384 characters are available.

Fig. 28-19 shows a character generator that can generate hundreds of characters for any CRT, each character formed by 5 horizontal and 7 vertical dots; 10,000 characters per second can be generated.

In the "Typotron" (Fig. 28-20) the beam is shaped inside the cathode-ray tube by an etched disc. The display rate is 25,000 characters per second. A 6-bit binary code selects any of 64 characters; a 10-bit code then selects any 1 of 1024 possible positions on the face of the tube.

Fig. 28-21 shows the "Charactron" which also shapes the character inside the tube. The data display rate is 20,000 characters per second; a 6-bit code selects the character; a 20-bit signal then selects the spot at which the character appears.

The technical specifications, input signals and features of these and other digital readout equipments will be surveyed in the September issue of *I&A*.

A future issue will also deal with digital printouts, such as the Monroe Data Log Series printers shown in Fig. 28-22.

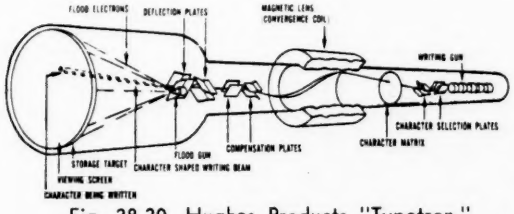


Fig. 28-20. Hughes Products "Typotron."

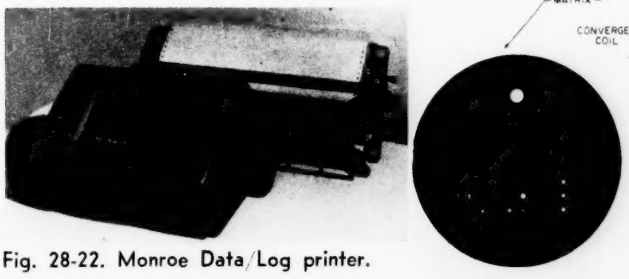


Fig. 28-22. Monroe Data/Log printer.

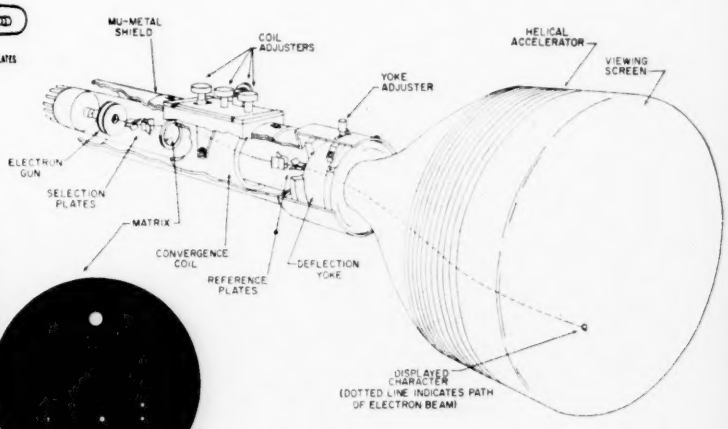


Fig. 28-21. Stromberg-Carlson "Charactron."

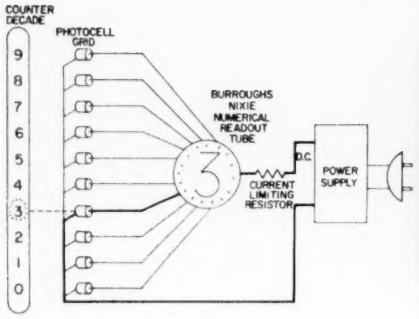


FIG. 1. SCHEMATIC of Digiverter operation.

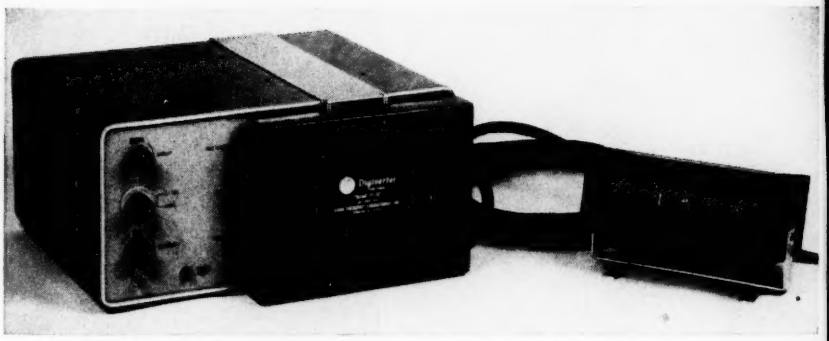


FIG. 2. DIGIVERTER mounted on decade counter.

The Digiverter—A Digital Readout Converter

This photoelectronic system translates a vertical decimal display directly to an inline display without relays, tubes, transistors, moving parts, or any circuit connections to the digital readout system.

HORACE R. FINNEY
Radio Frequency Laboratories, Inc.

OF THE many types of digital (both decimal and binary) readout devices, the decade counting unit (using small neon NE-2 lights) is one of the most popular: these "DCU's" are widely used in counters, frequency meters, digital voltmeters, etc. Their popularity is due to the factors of economy, simplicity and dependability. However, they present a reading problem because the numbers are small and usually arranged vertically, leading to reading fatigue and human errors where readings must be taken in rapid succession. This problem was encountered in filter production and production testing.

It was established that errors would be reduced if the readout were larger, brighter, and in-line, and a photoelectric device, the Digiverter*, was produced to convert the standard decade or binary counting unit into an in-line larger-character readout. In effect this is a unit for converting a vertical decade counting readout into a horizontal Nixie in-line readout.

The Digiverter

A single decade uses ten photosensitive units, each of which reads one of the illuminated numbers on a vertical decade counter unit (Fig. 1). When the numeral is dark the cell holds off the firing of the appropriate Nixie cathode. When the numeral is illuminated the cell allows the cathode to fire and present its number. In this manner the cells act as current gates on the cathodes.

The Digiverter is powered by a full-wave voltage-doubler supply from a nominal 115-volt a-c power source of from 50 to 2400 cycles. Its power consumption is approximately 0.6 watt per decade.

Digiverters have been developed for all of the popular vertical decade counters and are available with either integral or remote in-line Nixie readout. The unit is easily attached to the front of a decade counter unit by two metal bands (Fig. 2). No electrical connection to the counter is required.

The Digiverter is a simple means of obtaining in-line readout from the older type of decade counters that do not have circuit termination provision for in-line readout matrix decoding. For the newer models, the Digiverter allows the existing circuit termination to be used for printer applications.

The same system also has been developed for individual DCU's and is known as the "Digidec" (Fig 3). All power required is obtained internally directly from the DCU.

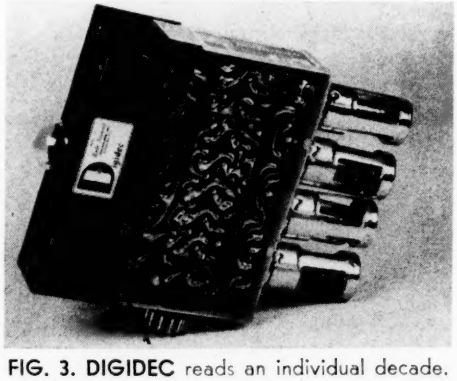


FIG. 3. DIGIDEC reads an individual decade.

*Trademark Radio Frequency Laboratories, Inc.

FIG. 1. AUTHORS Stanley Rogers (left) and John McLeod are shown at one of the two main control consoles of the Convair analog computer, the subject of this reliability study.

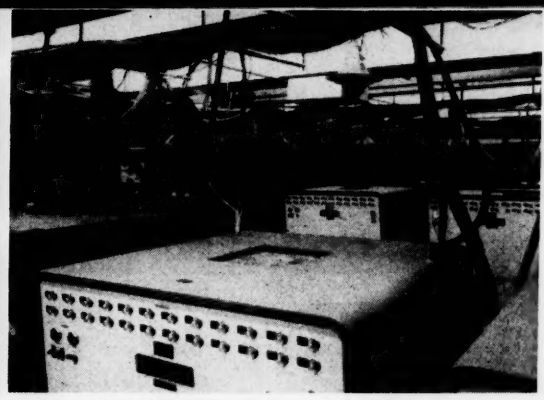


FIG. 2. EQUIPMENT located on the floor above the control consoles shows the amount of equipment involved in the reliability study.

WHAT PRICE COMPUTER RELIABILITY?

Are "Reliable" Tubes Reliable? Are Reliability Programs Helpful? This Convair Program Gives Some Answers.

STANLEY ROGERS
Convair-San Diego

JOHN McLEOD
Convair-Astronautics

"A Little Neglect May Breed Mischief" is probably even more pertinent today than when Benjamin Franklin wrote it in his *Poor Richard's Almanac* 200 years ago. You may recall that he followed this magnificant understatement with ". . . for the want of a nail a shoe was lost . . ." until a kingdom was lost.

Even if management will not buy the suggestion that a tube failure may cost us our way of life, a consideration of the economics of computer maintenance should be enlightening. For instance, in the Convair-San Diego Analog Computer Laboratory there are some 8,000 electron tubes, and over-all annual maintenance costs run into five figures. Hence data that lead to improved efficiency and reduced costs are certainly worth collecting and analyzing. This article is an interim report on a Convair program designed to do just that.

The program on which this article is based was put into effect in the Convair-San Diego Analog Computer Lab (Fig. 1) on October 1, 1956, because it was felt that a way could be found to measure the effectiveness of maintenance in quantitative terms, as follows:

(1) Are failures of any particular tube types abnormally high?

(2) Are failures of computing components (such as specific types of power supplies or amplifiers) abnormally high?

(3) Are any individual components failing abnormally with respect to the average for that type of component?

(4) Do failures increase significantly during non-continuous operation?

(5) Is there a correlation between ambient conditions and failure rates? In particular, do components in the parts of racks where it is warmer fail more often than those in the cooler parts?

(6) Does it really pay to use high-priced reliable types of electron tubes instead of the standard mass-produced types?

(7) Does preventive maintenance really pay?

(8) How much good will marginal checking do?

Many of these questions cannot be answered yet. Perhaps a few of them cannot be answered for a long time. However, the procedures in use at San Diego and the information being collected should be of interest to other laboratories with analog computing equipment. The size of the installation (Fig. 2)—some 560 operational amplifiers and allied equipment—makes possible the relatively rapid collection of data based on enough experience to be statistically significant.

Data Collecting Procedure

When a technician finds a computer component that is not performing satisfactorily, he makes out a *Failure Report* (Fig. 3), which is on one side of a form sheet. This sheet requests basic statistical information such as the date, time of day, whether the failure was discovered during checkout or normal operating time, what failed (type, make, serial number), and (to help the repairman) what the symptoms of failure were.

The faulty component, with report attached, is set on a "bad shelf." Repairmen take the equipment from

FIG. 3. THIS FAILURE REPORT is made out by the technician who removes the defective component.

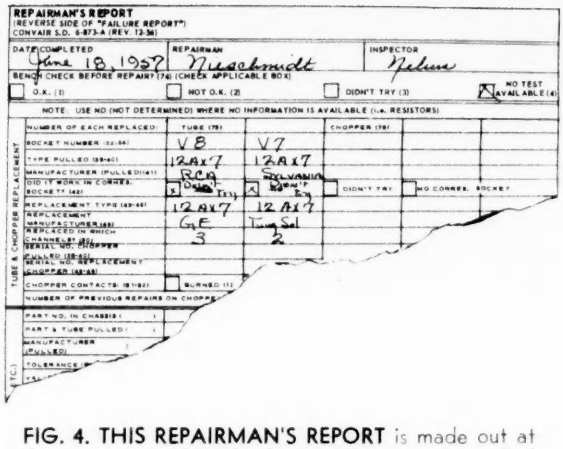


FIG. 4. THIS REPAIRMAN'S REPORT is made out at the test bench when the faulty component is readied for service. Data are coded and entered on IBM cards.

the "bad shelf," check, and repair it. They then fill out the *Repairman's Report* (Fig. 4), which is the reverse side of the Failure Report. The report and all parts removed in the course of making the repair are then placed on the inspection table.

The inspector examines the repaired component and, if it is all right, puts it on the "good shelf." An analyst picks up the form sheet and parts that were removed. He tries to determine what was wrong with each part and adds this information at the bottom of the Repairman's Report.

Test Limitations

Data from these report sheets are transferred to IBM cards, which are sorted and tabulated to extract the desired information. Most of the ensuing discussion is based on data covering a five-month interval. The section dealing with electron tubes covers a nine-month period.

When analyzing these data, two important factors must be considered: First, with few exceptions, both heater and plate power were on continuously seven days a week. Second, with few exceptions, only reliable types of tubes were used for replacement.

This means that the average standard type of tube had more service than the average reliable type. However, it also means that the bulk of failures, which usually show up within the first 50 to 100 hours of operation, were included for the most part in figures for the reliable types.

Total Failures

During the first five months, a total of 536 failures of all types was recorded. This means that, on the average, the facility experienced a failure somewhere every 6.7 hours. During the last two months of the period, the mean time between failures increased 10% to 7.4 hours. A total of 78% of the failures was found during the daily checkout, which is conducted every morning before the machine is released to the first-shift operators. Failures during operating time—that is, while problems are being solved—occurred on the average once every 48 hours. This figure was the same for the last two months of the period as for the whole period.

We may conclude from these figures that there was probably a small improvement in the over-all effectiveness of the maintenance program during the five-month period. This improvement, however, did not reduce the number of failures experienced by operators while solving problems.

Electro-mechanical Equipment failures

For the electro-mechanical equipment (servo multipliers and resolvers) the average time between failures for the five-month period was 35 hours, and for the last two months, 51 hours. The individual servos and resolvers had a mean trouble-free life for the five-month period of 3.9 months, and for the last two months of the period, 5.6 months. This indicates a probable improvement in the quality of the maintenance for this type of equipment. Because of the small number of failures there is doubt as to the statistical significance of the improvement.

Amplifier Failures

There are, of course, more operational amplifiers than any other type of computing component. Most of these come two per chassis. The total number of chassis in active service is 322. The total number of failures experienced was 195. The mean time between failures was therefore 18 hours. The mean operating time (between failures) for any one operational-amplifier *chassis* was 8.3 months.

One difficulty is that a certain number of amplifiers are removed from service because they show an apparent fault when connected to operating consoles. However, when checked on the bench they operate satisfactorily. Such a pseudofailure occurs about once a day, which suggests that the bench checks are not adequate.

Considering only the 190 amplifier failures on which complete data are available, the mean time between pseudofailures during operation of the computer (problem solving) was nearly 3½ days. If we

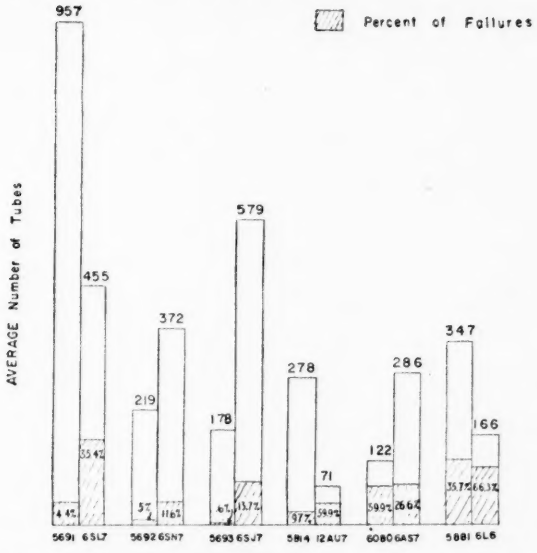


FIG. 5. BAR COMPARISON of tube failures over a nine-month period for reliable types (left bar in each pair) and its commercial counterpart. Bar height represents number of tubes of that type in service. Shaded portion shows percent failures.

assume these amplifier failures (on which complete failure information is available) as being typical. 84.2% of all amplifier failures are caused by tubes alone, 7.5% by choppers alone, and 8.3% by both tubes and choppers. The mean time between chopper failures was about one week.

Tube Failure Study

Electron-tube failure data for a nine-month period were analyzed to find out how standard and reliable tubes compared in performance. A comparison was made for six basic tube types. (Fig. 5). The reliable type is identified by its special type number. The standard type is indicated by a generic number under which are grouped all varieties. For example, 6SL7 covers 6SL7A, 6SL7L, 6SL7GT, 6SL7W and 6SL7-WGT.

The chart shows some startling contrasts between the standard and reliable types. On the assumption (which seems valid) that the tube failures follow a Poisson distribution, the statistical significances can be determined from an "M" table. (Such a table was prepared on the IBM 650 computer.) These tables showed all but one of the differences to be statistically significant at a confidence level of 0.99 or better* and, in many cases, 0.999 or better. Only one—the 5692-6SN7 comparison—showed a lower confidence level (estimated as 0.98). Since data having a confidence level of 0.95 are considered to give reliable information, all the comparisons may be regarded as meaningful.

In general, the chart shows that reliable types give far longer service than their standard commercial counterparts. The ratio of failures in the nine-month period between the reliable types and standard tubes varies all the way from 1.8-to-1 to 23-to-1. The latter is the record of the 5693 versus the 6SJ7. Only 0.6% of the 5693's failed in that period, while 13.8% of the 6SJ7's failed.

A comparison of the 5691 with the 6SL7 is also impressive. While 35.4% of the 6SL7's failed in that period, only 4.4% of the 5691's failed. A substantial number of the 5691's have been in service for several years. Hence they were exposed to approximately the same hazard of deterioration from long service as were the 6SL7's.

The figures suggest that the 5691 should have a life eight times as long as the 6SL7. However, before anyone rushes out to buy a carton of 5691's to use as replacements, he should pause and consider—the 5691 takes twice as much heater current as the 6SL7!

Failure rates for both the 5881 (35.7%) and its counterpart, the 6L6 (66.3%), were high. We have taken the following step toward improving the service life of these output tubes: About 100 amplifiers, which formerly used these tubes, were converted recently to a cascode type of output circuit. Power dissipated in the new output tubes (Type 6BL7) is very much reduced; hence we expect a much lower failure rate.

Similar modification of more than 100 additional amplifiers is now planned. Eventually all operational amplifiers will, no doubt, be converted. (There are other advantages to the cascode output.)

Effect of Bulb Temperature

The one apparently sour note in the table is the comparison of the 6080 and the 6AS7. The 6080's, which are "reliable" tubes, failed at a rate 2.2 times as great as that of the 6AS7's. Investigation disclosed that most of the 6080's were in one make of power supply where bulb temperatures were extremely high. In addition, an examination of tubes which failed indicated that many bulbs were cracked, a common consequence of excessive bulb temperatures. The 6AS7's, which performed relatively well, were nearly all in power supplies where ambient temperatures and bulb temperatures were much lower.

Tests are now being planned with heat-dissipating shields on the 6080 to see whether these will reduce bulb temperatures and permit a more satisfactory life. Also, the new 6080-WB tubes (with high-temperature-glass bulb) have been installed in half of the power supplies where temperatures are excessive. Relative performance will be observed carefully.

As the program continues and more data are analyzed, it is expected that more questions can be answered. Results already obtained, besides settling the question of the comparative reliability of reliable tubes *for this application*, have proven one important point: Measuring the effectiveness of maintenance procedures and policies can pay off.

*It's 0.99 to 0.01 that the test figures show a true picture.

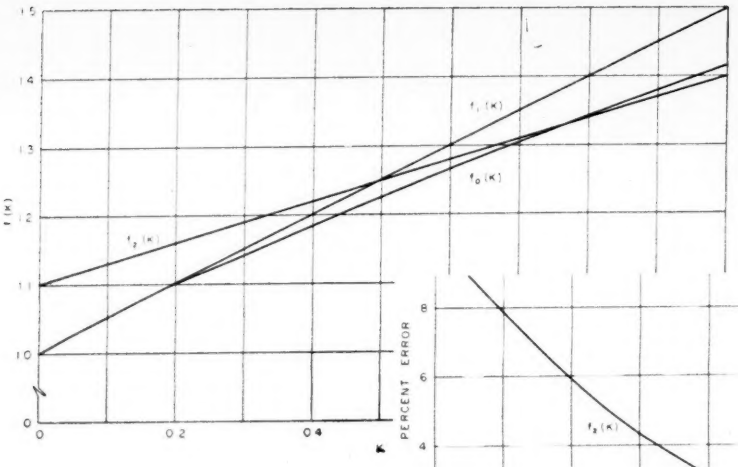


Fig. 1. Approximations to $f_0(K) = \sqrt{1+K}$

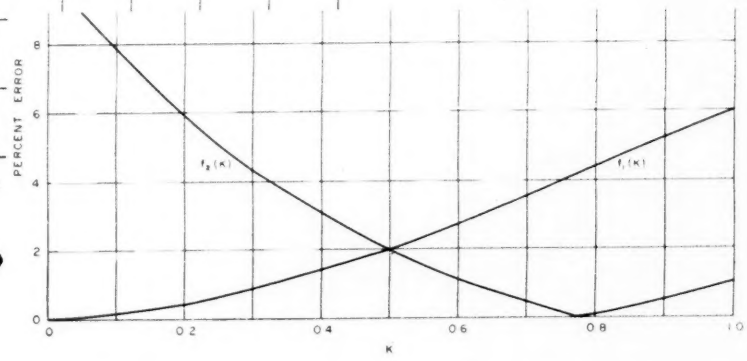


Fig. 2. Approximation errors as functions of K.

SQUARE ROOT APPROXIMATION

LESLIE R. AXELROD, Cook Electric Company

IT IS customary to approximate $\sqrt{A^2+B^2}$ by using the first two terms of the binomial series:

$$\sqrt{A^2+B^2} \approx A + B^2/2A \quad (1)$$

This binomial approximation is usually considered valid only for $B^2/A^2 \leqq 0.4$. However, it will be instructive to examine equation (1) further. In order to simplify the mathematics, let $B^2/A^2 = K$. Then:

$$\sqrt{A^2+B^2} = A\sqrt{1+K}$$
$$0 \leqq K \leqq 1 \quad (2)$$

Equation (1) can then be restated:

$$\sqrt{1+K} \approx 1 + K/2 \quad (3)$$

Thus, by a comparison of the right- and left-hand sides of equation (3), the values of B^2/A^2 for which the binomial approximation is valid, can be determined quickly.

Fig. 1 shows graphically both $\sqrt{1+K}$, or $[f_0(K)]$ and $1 + K/2$, or $[f_1(K)]$ as functions of K. It is evident that the binomial approximation becomes poorer as K increases. On the other hand, it can be seen that the straight line $f_2(K) = 1.1 + 0.3K$ becomes a poorer approximation as K decreases.

Fig. 2 shows the percent error in both approximations as functions of K. It is apparent that if $\sqrt{1+K}$ were to be approximated by $f_1(K)$ for $K \leqq 0.5$, and by $f_2(K)$ for $K \geqq 0.5$, the approximation error would never be greater than 2.1% (See Fig. 3).

As an extension of the binomial approximation, the author therefore proposes the following *Bilinear Approximation*:

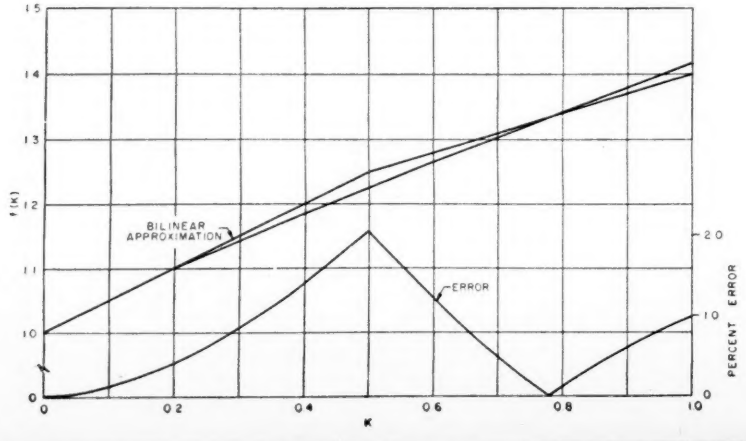
For $B^2/A^2 \geqq 0.5$:

$$\sqrt{A^2+B^2} \approx A + 0.5\,B^2/A \quad (4a)$$

For $B^2/A^2 \leqq 0.5$:

$$\sqrt{A^2+B^2} \approx 1.1A + 0.3\,B^2/A \quad (4b)$$

Fig. 3. The bilinear approximation and associated error.



Example 1.

Evaluate $\sqrt{85}$ to four significant figures:

$$\sqrt{85} = 9.220$$

Using equation (4a):

$$\sqrt{85} = \sqrt{81+4}$$
$$\approx 9 + 2/9 = 9.222$$

Using equation (4b):

$$\sqrt{85} = \sqrt{49+36}$$
$$\approx 7.7 + 10.8/7 = 9.242$$

Either way the error is much less than 1%.

Example 2.

It is desired to find the resultant of a vector whose X and Y components are 19.3 and 24.1 Letting R = magnitude of the resultant, we have: $R = \sqrt{24.1^2 + 19.3^2}$

Since $19.3/24.1 > 0.71$, $19.3^2/24.1^2 > 0.5$ and equation (4b) applies.

$$R \approx (1.1)(24.1) + (0.3)(19.31)^2/24.1$$
$$= 26.45 + 46$$
$$= 31.05$$

Exactly,

$$R = \sqrt{581+372}$$
$$= \sqrt{953}$$
$$= 30.87$$

Error = 0.58%

SIMULATION

Based on the Simulation Bulletins of Electronic Associates, Inc.

DETERMINE the positional response (x vs t) of a spring-mass system (Fig. 1) to initial displacements for various values of damping (D), mass (M) and spring constant (K).

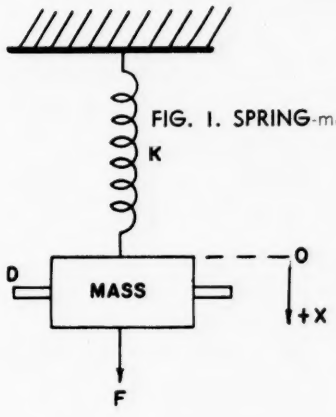


FIG. 1. SPRING-mass-damping problem.

Equations

The forces on the mass are (1) spring force, f_K, (2) damping force, f_D, (3) inertia force, f_M, (4) gravity force, f_g, and (5) applied force F_a:

Spring force $f_K = -(Mg + Kx)$
Damping force $f_D = -D(dx/dt) = -D\dot{x}$
Inertia force $f_M = -M(d^2x/dt^2) = -M\ddot{x}$
Gravity force $f_g = +Mg$
Applied force $f_a = +F = F(t)$
The sum of these five forces must equal zero:

$$-M\ddot{x} - D\dot{x} - Kx + F = 0 \qquad (1)$$

This is the equation to be solved. It can be rewritten:

$$\ddot{x} = -(D/M)\dot{x} - (K/M)x + F/M \qquad (2)$$

Simulation

As equation (2) involves a second-order differentiation, the simulation circuit will require two integrators. Fig. 2 shows two integrators, with input to the first being $\ddot{x}$, the output x. Note that the amplifier shown at right only changes the sign of x.

As no external forcing function (F) is to be applied, F = 0, and the equation to be solved becomes:

$$\ddot{x} = -(D/M)\dot{x} - (K/M)x$$

This is done by multiplying $-\dot{x}$ by (D/M) and $-x$ by (K/M), as shown in Fig. 3.

Considering the voltage levels involved, a practical hook-up is shown in Fig. 4. Note that 10x is divided by K/20M in pot 3 and then multiplied by 2 (1 + 1) to give (K/M) x.

Pot 1 is used to set the initial displacement of the mass (x_0). As its value is (x_0/10), when it is set to 0.4 the initial displacement is 4.0 inches.

Actual values used for two cases were:

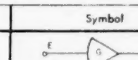
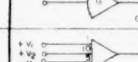
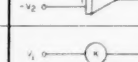
	Case 1	Case 2
Mass M (lb-sec²/in)	1.0	1.0
Damping Coefficient D (lb-sec/in)	6.0	10.0
Spring constant K (lb/in)	20.0	20.0

These values are used to calculate the pot settings as follows:

	Pot 1 (x_0/10)	*Pot 2* (D/10M)	*Pot 3* (K/20M)
Case 1	0.400	0.6000	1.000
Case 2	0.400	1.000	1.000

The circuit of Fig. 4 is quickly set up on the patchboard of an analog computer, the pots set as given in the table, the velocity $\dot{x}$ is read out at the square block marked "1"; the displacement at the block marked "2."

Table 1—Symbols used

Name	Symbol	Function	Description
High Gain Amplifier		$V_0 = -G\,E$	Operational Amplifier
Summer		$V_0 = -(V_1 + 10V_2 - 5V_3)$	Amplifier Multiple Input
Integrator		$V_0 = -\int_0^t (5V_1 - V_2)\,dt$	Amplifier Multiple Input
Coefficient Potentiometer		$V_0 = K V_1$ $0 < K < 1$	Manually Set Potentiometer

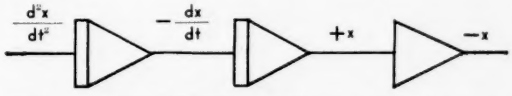


FIG. 2. TWO INTEGRATORS are required for a second-order differential.

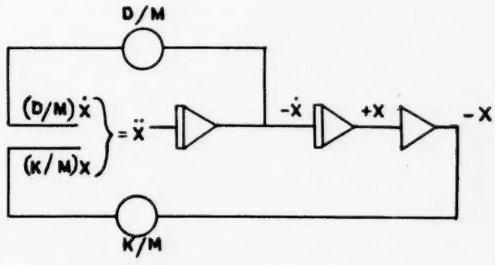
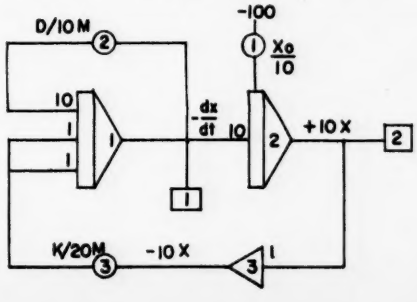


FIG. 3. EQUATING d^2x/dt^2 to its two factors.

FIG. 4. FINAL simulation circuit



A Novel Thermostat for Hot Rollers

Sensing temperature of a moving surface, such as a hot roller, is a difficult problem. After a review of present techniques, a new method is presented for deducing the roll temperature from the resistance change of an inductively-heated roll.

D. A. SENIOR

Middlesex, England

TEMPERATURE control presents special problems when the working part is in motion, such as hot rollers where the roll surface temperature must be maintained with a few degrees of a set point. If the roll is to be run at constant speed for long periods of time, the simplest solution is to use a roller of high thermal capacity to smooth out minor fluctuations in thermal load. However, if load fluctuations are large, then a high-thermal-capacity roller can slow down the response to changes in the heat input so that it is impossible to hold the roller temperature within the prescribed limits.

Large abrupt fluctuations in load require low thermal inertia in the roller heat system and rapid response in the temperature sensing device so that the control system will not limit the speed of the machine.

Systems in General Use

Heat to a moving element is normally supplied by gas flame, steam, hot liquids, radiant heat, or electric elements. In this last case the element can be incorporated in the moving part and fed through slip rings. The choice among the different methods depends on the temperatures required, but the convenience of operation gives electrical systems an advantage.

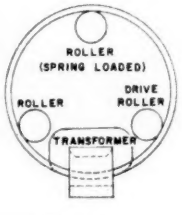


FIG. 1. HOT ROLLER coupled with coil.

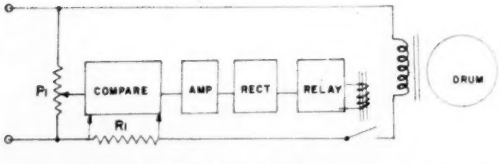


FIG. 2. BLOCK DIAGRAM of temperature control circuit.

Temperature Sensing

Thermocouple and resistance thermometer elements can be incorporated in the moving part and the electrical signal brought out through slip rings. This presents some difficulty from varying contact resistance at the slip rings. Sometimes the thermocouple element is pressed in contact with the surface of the roller. This gives good thermal contact and rapid response but suffers from the effects of frictional heat. A more robust rubbing contact often used takes the form of a shoe cut to the same curvature as the roller. The shoe contains either a resistance element, a thermocouple, or a mercury-in-steel thermometer; this depends on expected roller temperature.

Another system employs an air inlet placed close to the roller. The roller temperature is deduced from that of the air.

Photocells are gaining popularity. These depend on thermal radiation and have the advantage that contact with the moving part is not required. Until comparatively recently their application was restricted to high temperatures as they were sensitive only to visible light and the shorter wavelengths in the infrared. Neither the infrared type barrier-layer cell nor the caesium/silver-oxide photoemissive cell has much sensitivity to wavelengths exceeding 1 micron. The modern lead sulphide photoconductive cells, however, have a spectral response extending beyond 3 microns; that of lead telluride cells extends almost to 6 microns. These cells can detect radiation from bodies at temperatures as low as 100° C.

None of the systems which have been described for supplying heat or for measuring the temperature is entirely satisfactory if a high speed of response and close control of temperature are needed. The device to be described has been developed to meet this requirement.

Principle of Operation

The roller, or drum, is used as its own heating element and temperature sensor. The drum is a copper spinning—10" dia. 0.060" thick and 3" wide in the present model.

The drum is mounted on three rollers (Fig. 1), and is driven by one of the rollers. It is magnetically

coupled with a coil as shown and acts as a single-turn, short-circuited secondary winding. In operation, the heating current induced in the drum is about 2000-3000 amps and the power generated with the present drum is 500 to 1000 watts, depending on the size of the coil. The thermal capacity is low and the drum warms up from cold to 120° C, the working temperature, in 90 seconds or less. The response of drum temperature to heat input is rapid and requires rapid sensing.

Temperature Control

Owing to the increase in electrical resistance of the drum as its temperature rises, the line current to the transformer drops about 10% during the warm up. It is this change in current with temperature that is used to control the heat supplied. The primary current is about 5 amps and changes 5 milliamps per °C change in drum temperature. This small change is insufficient to work a relay directly and provide good control.

A simple electronic circuit (Fig. 2) provides satisfactory drum temperature control. A small resistance (R_1) is included in the primary circuit of the load coil (T). The potential across this resistance drops as the drum warms up. The potential drop across R_1 is compared with a line-voltage reference taken from potentiometer P_1. This difference potential is amplified and rectified. When the working temperature is reached, the relay is energized and its contacts open to interrupt the transformer primary circuit. With the power cut off, the temperature of the drum begins to fall immediately. A timing capacitor restores power to the transformer after a few seconds and the cycle begins again. In this way the working temperature of the drum is kept within close limits.

Refinements included in newer models include null-balance comparison circuits that eliminate effects of line-voltage fluctuations, various drum-coil weights, and drum materials for different load ratings. Instead of on-off control, two-level current switching wherein the control circuit remains operative and can be set for the lower temperature limit, has been used successfully in a rapid processor for photographic records.

Acknowledgment

The writer is indebted to H. H. Margary who suggested the use of inductive heating and resistance variation with temperature. Patent rights on the invention are the property of The National Research Development Corporation. Thanks are due to the Admiralty for permission to publish this paper.

A Digital Control Valve

T. GIZESKI, Ferguson-Hille & Associates, Inc.

CONTROL VALVES of all types are analog devices, requiring servomotors or follow-up systems to translate a signal into a motion which in turn changes the area of a flow passage (valve port). A new concept makes a digital control valve out of ordinary on-off valves.

A nominal number of on-off valves (solenoid valves are shown in Fig. 1) are piped in parallel into an inlet and an outlet manifold. The port areas are proportioned to conform to the binary progression—that is, a six-unit control-valve assembly will have port areas of 1, 2, 4, 8, 16, and 32 units of area, permitting 64 discrete control points (63 flow-control points plus zero flow). An assembly of 7 valves would give a total of 128 control points, permitting control to 1 part in 128. Using 10 valves would permit control to 1 part in 1024.

The digital valve assembly can be used in a variety of systems. Recording controllers, analog computers, digital computers, or manual control can be employed equally well in conjunction with the digital device. Digital outputs can be fed directly to the assembly, obviating the digital conversion equipment now required with use of conventional control valves. The digital valve thus advances the digital computer to a prime element in process control, requiring no digital conversion equipment for the final control element.

9 various types of assemblies are available, with nominal size of $\frac{1}{2}$" to 6" (flanged or screwed inlet or outlet).

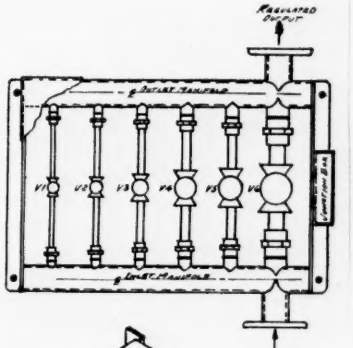


FIG. 1. DRV-64 has 6 valves, 64 control points.

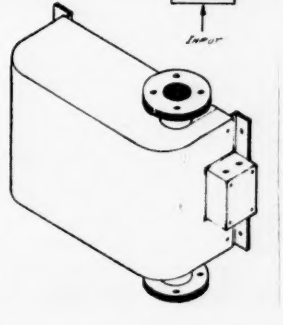
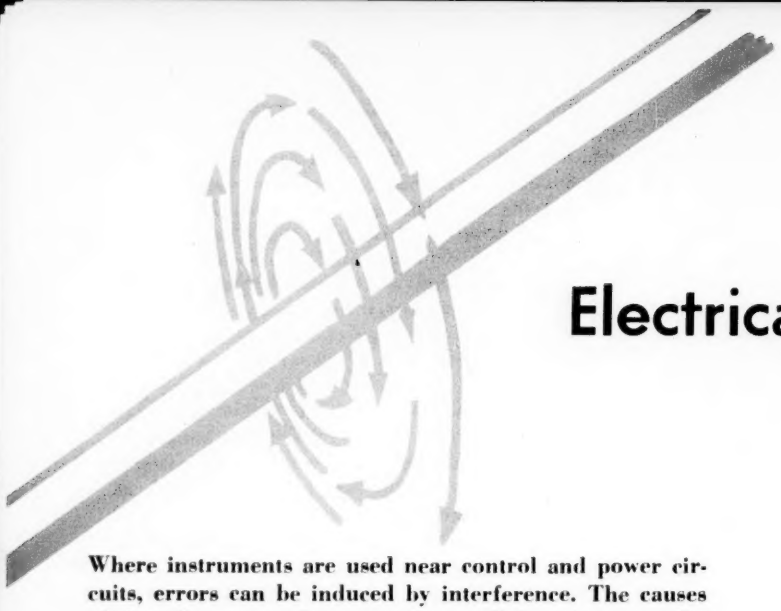


FIG. 2. APPEARANCE of digital valve.



Electrical Interference

Where instruments are used near control and power circuits, errors can be induced by interference. The causes of interference and types of remedial action are discussed, including (1) reducing the cause of interference, (2) neutralizing the means by which it is transferred, (3) applying corrective action after it is transferred.

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Army Electronic Proving Ground
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INTERFERENCE can originate from magnetic or electrostatic fields, either constant, low-frequency, or radio-frequency. In *magnetic coupling* a magnetic field is set up by the interfering device or circuit which links the instrumentation device or circuit. *Electrostatic coupling* is due to the potential difference between the interfering source and the instrumentation, resulting in electrostatic lines of force linking the two. Both types of fields can cause interference and errors in instrumentation circuits.

Magnetic Fields

The magnetic field surrounding a magnet or a conductor carrying direct current can cause an error in a nearby unshielded electrical indicator. The solution is either *magnetic shielding* or *physical separation*. A-c-operated solenoids, regulating transformers, or conductors carrying an alternating current can cause errors which appear steady as long as the effective value of the ac is constant. Direct current also can cause interference in nearby circuits when there is a sudden change in the current.

Electrostatic Fields

Strong electrostatic fields surround high-voltage magnetos, ignition leads, x-ray cable, insulated aerial lines, or lines running over dry soil, etc., unless such items have been shielded and the shield properly grounded. An electrostatic field on the glass front of an electrical indicating instrument can cause error. Such a charge can result from polishing the face of the indicator when low humidity prevails, or from a nearby unshielded high-voltage wire or device.

Static electricity is prevalent on rope drives, belting, or other nonconducting conveyors. In arid regions or on sandy or rocky terrain, potentials measured by an electrostatic voltmeter can reach hundreds of volts between ground and insulated wire or an ungrounded structure. This potential can be due to charged dust particles or a cloud overhead. Instrumentation circuits can pick up interference when run along such structures even though the circuit is shielded. Under such conditions it is necessary to insulate or separate shielded lines from ungrounded structures. Also, a good ground connected to the structure reduces the possibility of sparking to the shield.

Radio-Frequency Interference

Most common radio-frequency interference is generated in making or breaking a reactive circuit such as the rapid collapse of the magnetic field of solenoids. If this appears periodically, it can seem to be caused by a low-frequency source when actually it results from a series of high-frequency damped oscillations.

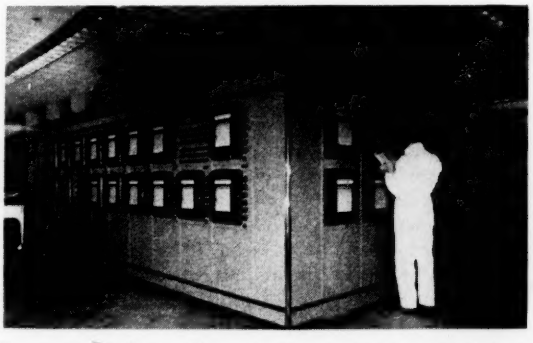


Fig. 1. Recorders with controls mounted immediately to the right of each recorder permit short leads to reduce possibility of "crosstalk" between nearby circuits.

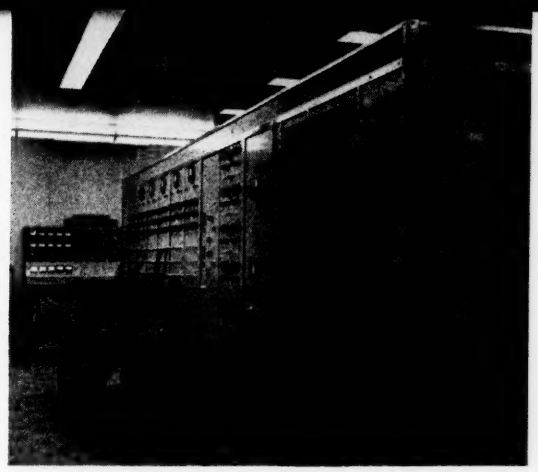


Fig. 2. One side of instrumentation cubicle, showing shielded cables connected to recording oscillographs.

Any r-f current-carrying conductor radiates radio-frequency energy, and any conductor not properly shielded can absorb a portion of this energy. In addition, a certain amount of radio-frequency energy can extend a great distance along these conductors in the form of standing waves in which the voltage (and current) reaches a maximum every quarter wavelength; the current maxima are at different locations from the voltage maxima. Radio frequencies often cover a wide frequency spectrum, setting up a series of standing waves. An ungrounded shield can easily develop standing waves, even if the shield is grounded at one point. The safest procedure is grounding a number of locations by direct connection or by capacitor.

Radio-frequency energy also can be imparted to conductors which then carry and transfer the interference to instrumentation circuits. Switching off a circuit which is not a prime offender can remove the interference by disconnecting the link between the source and the instrumentation circuit. On the other hand, switching *on* a circuit can remove interference if that circuit has a low-impedance device which "grounds out" the induced interference. Thus it can be seen that with a large number of circuits in close proximity, confusing results can be obtained from opening and closing various combinations of circuits.

Interference Generated by Instrumentation

An instrumentation circuit can induce noise in a second instrumentation circuit if there is insufficient separation (Fig. 1) or shielding (Fig. 2) between them. A line carrying oscillator power to a variable-reluctance pickup at 20 volts and 3000 cycles per second can result in a false indication in a nearby unshielded low-energy pickup circuit. Instrumentation circuits can cause interference in control circuits, especially those which require amplification. A photoelectric-cell circuit can give false responses if sufficient stray voltages are induced.

Detecting Interference

A simple way to detect interference is to operate instrumentation equipment without actuating the pickup, but with control and power circuits in operation. *Then all indications are spurious.*

A telephone headset or receiver will locate static charges, direct-current and low-frequency pickup by responding to surges due to closing and opening adjacent unshielded d-c circuits. A 1-microfarad capacitor in series with the headset will eliminate dc through the headset. Without the series capacitor the headset will respond with a click that occurs, when d-c leakage is detected, on closing and opening the headset circuit. If a germanium crystal diode is connected in series with the headset, it is more responsive to some high-frequency types of interference which might otherwise escape detection.

Reducing the Cause

As magnetic and electrostatic coupling are reduced with distance, separation of interfering circuits from instrumentation circuits is often the most satisfactory solution.

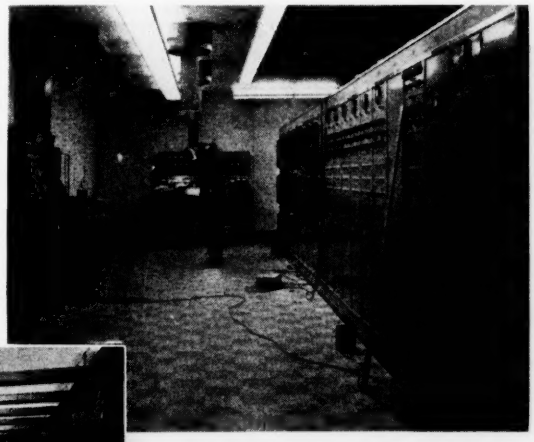


Fig. 3. Instrumetation cubicle (top) is separated from control consoles on left. (Left): Inside the cubicle, isolated circuits run through overhead channels, conduit and floor channeling.

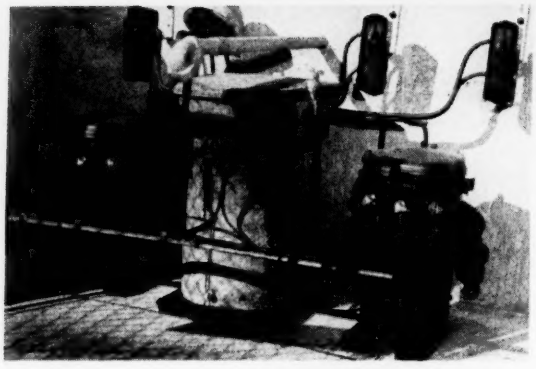


Fig. 4. Power transformers installed outside, showing method of grounding cases.

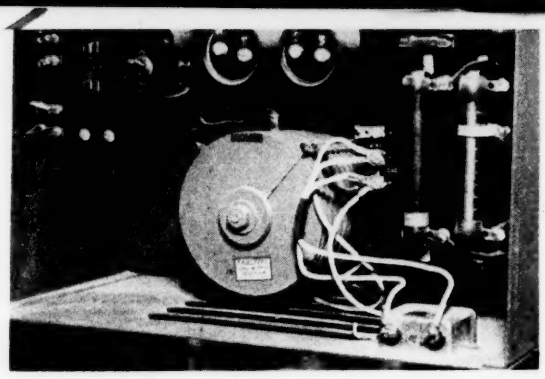


Fig. 5. "Bathtub" capacitor, lower right, reduces interference originating from rectifier.

Arcing across low-voltage contacts often is reduced effectively by a 0.5-microfarad capacitor connected in series with 100 ohms and placed across the contacts. Reducing the spark also reduces the radiation or induction from unshielded connecting leads.

Neutralizing Transfer

In general, the higher the signal level in the instrumentation circuit, the lower the impedance in the lines and across terminals, the less the trouble experienced from induced voltages.

Circuit impedance is often reduced by connecting capacitors to ground. Capacitance on the order of 0.01 microfarad will usually provide adequate radio-frequency grounding. Owing to standing waves along a conductor of considerable length, several capacitors can be employed where voltage is highest.

Fig. 5 shows use of a capacitor to reduce rectifier interference at its source.

Twisting leads (Fig. 6) is a standard procedure for cancelling interfering fields.

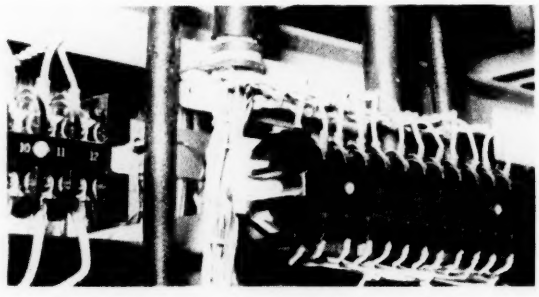


Fig. 6. Twisting leads is still a basic technique.

Shielding

Shielding with copper, aluminum, or other nonmagnetic material has some value against strong low-frequency magnetic fields, although these materials are most effective against high-frequency interference. A heavy-walled rigid steel conduit is more effective than nonmagnetic shielding in containing a low-frequency field because the magnetic field is diverted through the steel.

The conductivity and volume of the shield determine the eddy-current loss and consequent reduction of radio-frequency interference because eddy currents increase with frequency (Fig. 7). Both magnetic and nonmagnetic shielding, if grounded properly, can be effective against electrostatic fields because the electrostatic lines terminate on the shield rather than on the instrumentation circuitry. The electrostatic field is very important in high-frequency interference because a small capacitance between circuits is capable of carrying more current at high than at low frequencies.

The effectiveness of non-solid shielding depends on the closeness of weave, separation between turns or twists in armor, etc. A tightly woven tinned-copper braid is considered an effective radio-frequency shield against all but very-high-frequency fields of high intensity.

The effectiveness of a shield over a device which generates radio-frequency noise, such as one containing sparking contacts, varies enormously with the assembly of the shield. A metal cover which closes over a painted, greasy, or corroded surface is not very effective because the cover must be electrically continuous with the metal body. The body should be grounded, but not where the ground connection is common to an instrumentation ground. If they are common, there is coupling between noise ground and instrumentation ground, particularly if the common ground connection is a considerable distance from the actual ground (earth). In such a case, separate grounding means should be provided in order to reduce coupling.

Situations exist where shielded lines extend long lengths without the possibility of grounding the shields except at one point. In such instances it is advisable to keep the shields separated except where the ground connection is made because intermittent contact between shields due to vibration or expansion and contraction can induce noise. The offending circuit is more easily discovered if the shields are isolated by disconnecting them from ground one at a time. Insulation over the shield braid is assurance against interference due to casual contacts.

Grounds

A good ground (Fig. 9) is essential to reduction of interference. A water pipe is generally better than a gas pipe or steam pipe. A water pipe connected to an extensive underground system or well is better than if connected to a cistern. In many localities a ground rod

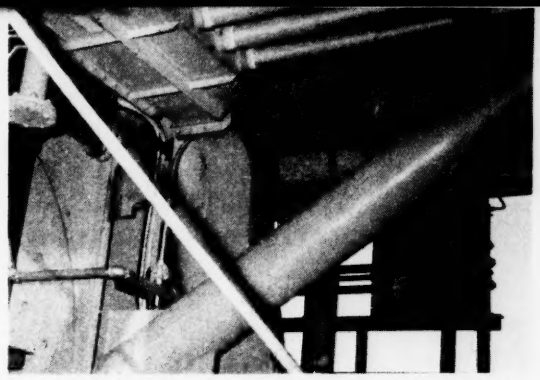


Fig. 7. Conduit and ducting used to contain pickup circuits provide shielding from outside fields. Cables inside are shielded from each other with non-magnetic material.

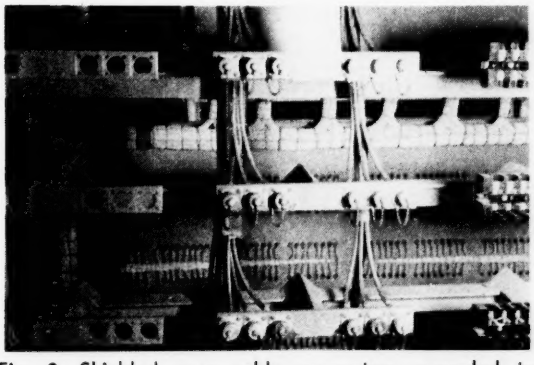


Fig. 8. Shielded coax cable connectors grounded to metal frame.

driven down six or seven feet is adequate for most purposes. In sandy regions, rocky terrain, or arid regions, such a ground rod may be useless except after a rain.

Buried wires or objects are used extensively for grounding purposes. This can best be done during the construction of buildings. Laying a heavy copper wire in the trench before footings are poured, in ditches carrying pipes and sewer lines, septic tanks and other excavations, constitute means of obtaining or improving grounds. Damp locations are preferable; charcoal or other means of absorbing or holding moisture are desirable. Wire fences employing steel posts or reinforced concrete posts, used because of the chance of crossing a damp spot, can be dangerous because of lightning. It is safer to use a buried wire run to the damp location. The practice of putting salt on buried copper wires to increase ground conductivity should be discontinued because the ensuing chemical reaction eventually destroys the copper; copper sulphate should be used instead.

Adding a ground at a second location spaced at some distance from the first ground *can increase over-all interference*. This can happen when the second ground connection is not a good ground and carries noise current, thereby inducing noise into the instrumentation circuit.

If additional grounding reduces radio-frequency noise but *increases* low-frequency noise, a capacitor can be used to ground the high-frequency noise without completing the circuit for low frequencies.

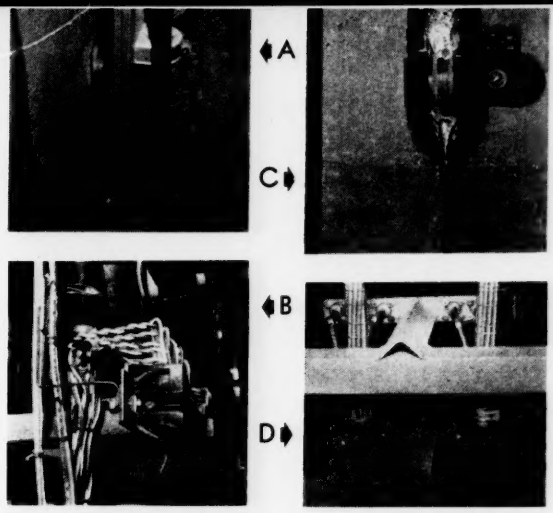


Fig. 9. Continuity of ground can be maintained through (A) clamps, (B) wire that bridges bolted connection, (C) soldered connection, (D) welded joint. The welded joint is best; the soldered connection is better than clamp or bolt.

Corrective Action

The first consideration should be increasing the signal level and thereby the signal-to-noise ratio.

Sometimes it is possible to increase the output of pickups or other instrumentation devices. A strain gage often can be operated at 6 volts rather than 3 volts. Sometimes a greater output can be achieved simply by changing the range of the pickup.

Filtering

Properly designed filters prevent induced currents from interfering with accuracy. If the interference frequency is well removed from the instrumentation carrier, simple filters can be employed without affecting the response time of the instrumentation. The filters can be connected to ground or between conductors to shunt out the interfering carrier frequency. However, the nearer the interference frequency is to the signal frequency, the more complex the filter must be. If the instrument circuit is not required to respond in a short period of time, the filtering can be simply parallel capacitance, series inductance, or both.

Pickups are susceptible to interference, particularly when the output depends on the unbalancing of a circuit. The filter must not reduce pickup output excessively.

Capacitors and filters can be used with strain-gage-type recording instruments without affecting the response up to one hundred cycles per second. If a thermocouple is used to actuate a recorder at the rate of only a few readings per second, filtering can be used without any difficulty. Connecting a capacitor of 0.5 to 10 microfarads across the input to a recorder or indicator as a filter has been used to eliminate the effects of interfering surges. However, too large a capacitor can reduce the time resolution of the system.

Illustrations are Official Photographs, USAF, Edwards Air Force Base.

ELECTRONIC

CHARLES F. KEZER

Digitronics Corp.

and

MILTON H. ARONSON

Instruments & Automation

SERIES-TRIGGERED BLOCKING OSCILLATOR

Applications of the series-triggered blocking oscillator in radar and computer circuits are basically the same as those of the parallel-triggered type (*I&A*, Feb., 1957). Circuit is NBS-BuAer Preferred Circuit PC49. However, the series-triggered circuit has the advantages of less delay between input and output, and ability to respond to a more slowly rising input trigger. It has the disadvantage, on the other hand, of loading the trigger source during the output pulse.

A type-5814A dual triode tube is used: one triode section (V2) is the blocking oscillator; the other half is used as an input cathode follower. V2 is normally biased to cutoff by negative voltage obtained from the voltage divider R3-R4. When a positive 30v-50v trigger is applied to the grid of V1, the grid of V2 receives a corresponding pulse, and plate current begins to flow in V2. This plate current flowing in the pulse transformer induces a voltage in its grid winding, of polarity to drive the grid more positive. This regeneration causes the

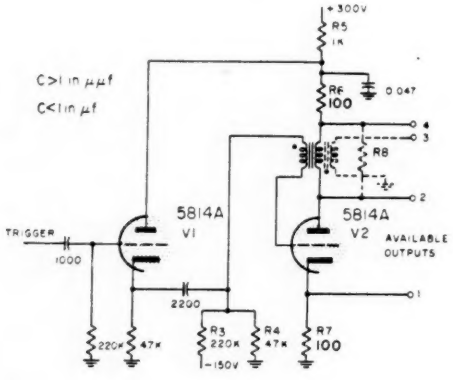


plate current to rise rapidly to about 250 ma, with heavy grid current (80 ma) being drawn simultaneously.

Duration and rise time of the current pulse are determined by transformer characteristics. At the end of the current pulse, the oscillator returns to its normally cut-off condition. The circuit is not ready to accept another trigger, however, until capacitor C2 has discharged to the fixed bias level. For the circuit shown, a recovery time of 500 usec between pulses is required. For pulse spacings of 60 to 500 usec, the recovery time-constant can be reduced by changing R3 to 47K ohms, R4 to 10K ohms, and R5 to 330 ohms.

For operation at pulse spacings of 12 to 60 usec, the time constant must be reduced still more by decreasing R3 to 22K ohms, R4 to 4.7K ohms, and C2 to 680 uuf. Reduction of C2 results in a decrease in pulse width of about 25%.

Loading of the trigger source during the output pulse results from the heavy flow of V2 grid current in the cathode resistor (R2) of V1. Direction of current flow is such as to drive the cathode of V1 negative with respect to its grid, producing grid current in V1. Loading of the trigger source can be minimized by connecting a diode across R2, with cathode connected to the V1 cathode, preventing the V1 cathode from being driven negative with respect to ground.

The circuit is relatively insensitive to power-supply voltage changes; heater voltage changes of 10% have negligible effect. Plate voltage changes of 10% produce output amplitude changes of 10% and a slight change in pulse width. Circuit is less affected if plate and bias voltages change together.

Capacitor tolerances are ±20%; tolerance of R3 and R4 is ±10%; tolerance for other resistors is ±20%.

Resistor R8 is sometimes required to prevent ringing; its value will normally be in the range of 3.3K to 10K ohms. Overshoot in the output can be eliminated by connecting a diode in parallel with R8.

Input: PRF 200 to 2000 pps. Trigger amplitude: 30 to 50 v.

Output: Pulse width: 0.1 to 5.0 usec (depends on transformer T1). Rise time: 0.05 to 0.5 usec (depends on transformer T1).

Terminal	1	2	3	4
Polarity	Positive	Negative	Either	Negative
Amplitude (open circuit)	38v	175v	175v	25v
Impedance	100 ohms	Z_0 of T1	Z_0 of T1	100 ohms
Maximum load C	500uuf	10uuf	10uuf	500uuf

Delay: 0.1 usec (measured between start of trigger and start of cathode output).

Source: Nav Aer 16-1-519. *Handbook of Preferred Circuits, Navy Aeronautical Electronic Equipment*. Bureau of Standards, Washington, D. C.

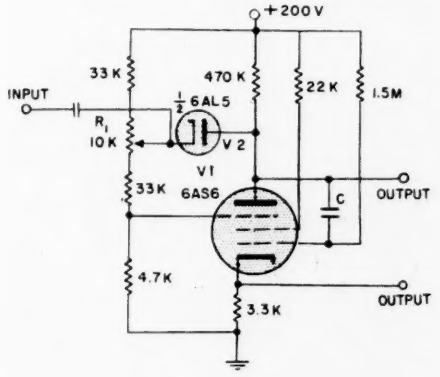
PHANTASTRON

Stability is the principal superiority of the phantastron over the one-shot multivibrator for frequency-division or time-delay generation. Its short-time stability (jitter) and sensitivity to changes in supply voltage are at least an order of magnitude better than the one-shot multivibrator. This phantastron circuit is available from supplier as plug-in module Z-90018.

The phantastron is triggered by a negative pulse via diode V2. The trigger produces a negative step at the plate, followed by a linear downward sweep. This sweep is linear rather than exponential because of "Miller integrator" action, generated by current in the capacitor C between grid and plate. When the plate voltage can decrease no further, an abrupt switching action takes place which depends on the negative transconductance existing between screen and suppressor grids. After this tran-

CIRCUITRY

The circuit is the heart of all electronics. Here are 3 more basic and interesting circuits. Unless marked, resistors are in ohms, capacitors in microfarads.



sient action, plate voltage continues to rise until limited by the "catcher" diode V2. Duration of plate sweep T is adjustable by means of the catching voltage potentiometer R_1, and by selection of the proper value of capacitor C. Value of C may be determined in circuit shown from $T = C/1.6$, where T is in usec, and C in uuf.

Frequency range (or triggering rate): 0 to 10 kc.

Outputs: At plate, 25-v negative step followed by 65 to 100 volt negative sweep, depending on setting of R7. At cathode, 17-v negative rectangular pulse.

B supply: 200 v at 10 ma.

Maximum duty cycle: 60%. Can be increased by using cathode follower to couple capacitor C.

Input signal: 20-v negative pulse, minimum, with rise time of 1.5 usec max.; 40-v minimum pulse with rise time of 6 usec max.

Source: Engineered Electronics Co., 506 E. First St., Santa Ana, Calif.

THE RADECHON STORAGE DEVICE

The Radechon is a developmental barrier-grid storage-tube designed to enable one or a few electrical reproductions of a video signal. It features random access, half-tone rendition of about 30 gray levels, limiting resolution of 400 lines per target diameter.

Information is stored as an electric charge pattern on a dielectric target. The same electron beam is used for reading and writing, as determined by a 20-volt switching signal.

The target structure consists of a thin sheet of insulator in contact with a fine mesh screen on one side, a metallized plate on the other, as shown. The primary electron beam strikes the screen and the insulator target. The insulator (target), back supporting plate, and screen element form a capacitor: the target as a whole is the continuum of such capacitors, each of which is the basic storage medium, or spot. As shown in the illustration, each spot capacitor is effectively two capacitors in series (C_s and C_p) with capacitance of about 0.2 uuf, and is charged or discharged by the electron beam.

Signals are stored as an electrostatic charge (energy) either by the deposition of electrons on, or the removal of electrons from, the surface of the insulator (target), as determined by the control of secondary electrons by the screen. The input signal usually is applied to the electron-gun control grid, and the output signal is the target discharge current. For writing, the entire target is brought to equilibrium potential by scanning with plate and screen at the same potential. The screen is held at fixed potential while the 20-volt charging voltage is applied to plate. The video signal is then applied to the control-gun grid (usually clamped to cutoff) while the beam is scanned across target in the desired pattern or raster.

For reading, following the writing process, the 20-volt charging voltage is removed from the plate, so that plate and screen are at substantially the same potential. All parts of the target that were not written upon are now back at equilibrium potential, whereas those portions that were written upon are negative with respect to the equilibrium potential by an amount equal to the potential difference through which they were discharged during writing. This negative voltage is the charging voltage for the reading process. Now both plate and screen are placed at relatively high impedance from ground, and the reading output signal is taken from the screen. The beam current is held steady (about 5 uamp) for one readout copy; it is reduced to obtain several (but not many) readout copies.

Resolution of storage tubes designed to reproduce picture signals is not described in terms of discrete target elements, but rather in terms of square waves (2 lines = 1 sine-wave cycle) per target diameter, or *lines per target diameter*. Resolution is limited by spot size (beam diameter), deflection stability (astigmatism), and field interaction.

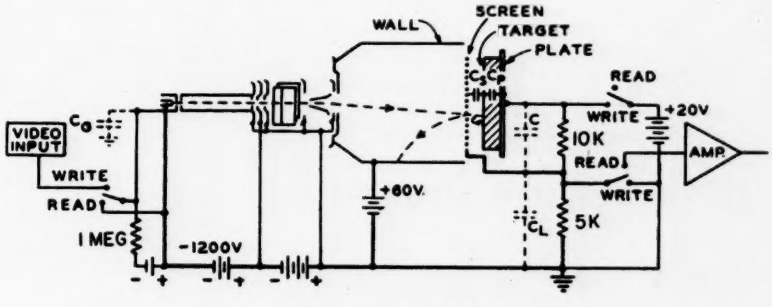
Resolution: limiting (horizontal) resolution is 400 lines per target diameter.

Input: 20-v peak to control grid.

Output: 30 mv at screen grid and plate.

Power supply: 1200-v d-c at 250 ua, 60-v d-c at 5 ua, and 20-v d-c at 2 ma.

Source: Arthur S. Jensen, RCA Laboratories, Princeton, N. J.; also *RCA Review*, June, 1955.



ANOTHER NEW LESLIE **PRODUCT**

ADJUSTABLE PROPORTIONAL BAND Floatless LIQUID LEVEL CONTROL

...with adjustable level ranges up to 0-200"

Here is a new differential pressure-type liquid level control pilot that combines the wide adjustable level ranges in the table shown below with a 2-20" or 7-25" adjustable proportional band.

ADJUSTABLE LEVEL RANGE — INCHES	ADJUSTABLE PROPORTIONAL BAND (INCHES, H_2O)	CONTROL PILOT TYPE
0-40 or 0-87	2-20	LAP
0-30 or 0-91	2-20	LABP
0-200	7-25	LAUP

Maximum Static Pressure — 300 psi

One Knob — Easy Adjustment

A single knob adjustment quickly sets the proportional band where you want it, even while the system is in operation. The liquid level is maintained constantly within that band until you re-set the control pilot for new conditions.

Applications

Leslie-Level-Matic Control Pilots are used in either open or pressurized vessels to control the level of virtually any liquid including water, gasoline, oil and chemical solutions. The new control pilot is particularly useful to maintain constant levels where there are high flow rates through vessels with small cross sectional areas.

Float Cages Eliminated

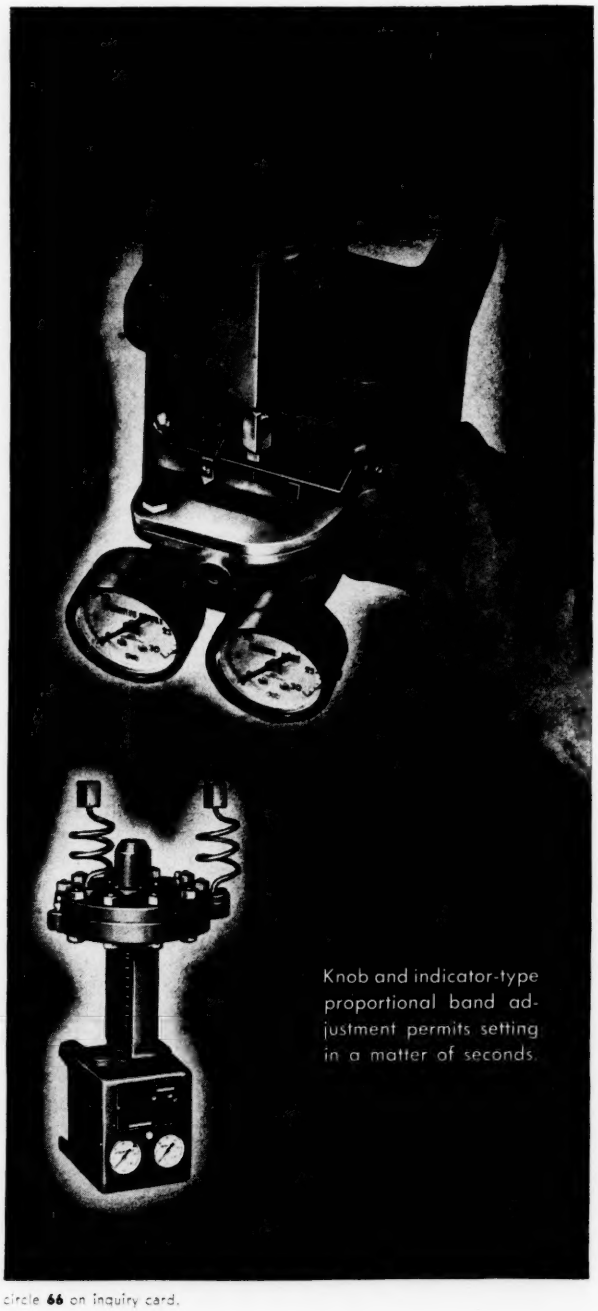
There are no floats or cages needed for Leslie-Level-Matic Control Pilots, and no torque tube seals, stuffing boxes, or thermohydraulic systems. All of the primary control elements are in one place and may be installed with a fraction of the effort and cost required for displacement-type controllers.

Vibration-Proof, Dependable

All of the dependability factors for which Leslie products are so well-known are incorporated in this new control pilot, as well. Rugged, accurate, stable — it is unaffected by normal vibration or turbulence.

More Information

Send for Engineering Data Sheet describing this new Control Pilot and outlining its principle of operation.



Knob and indicator-type proportional band adjustment permits setting in a matter of seconds.

LESLIE **REGULATORS and CONTROLLERS**

674

LESLIE CO., 299 Grant Avenue, Lyndhurst, New Jersey

For more information circle **66** on inquiry card.

Automatic Emergency Valves

CHESTER S. BEARD
General Controls Co.

FRED D. MARTON
Instruments & Automation

Emergency shut-off valves are either self-actuated or use an auxiliary source of energy.

PRECEDING chapters have been devoted to safety valves that open at a predetermined point (set point) to protect equipment from over-pressure. Equally important is the group of valves that close or open when other unsafe, emergency, or abnormal operating conditions occur.

Abnormal Operating Conditions

Abnormal operating conditions include: (1) loss of power, (2) high or low pressure in the system, (3) high or low temperature in the system, (4) abnormal fuel supply or combustion conditions, (5) excess flow caused by line breaks, (6) increase in chemical activity, (7) loss of control in nuclear reactors, and (8) abnormal fluid levels in equipment.

Direct Actuation

It is apparent that the emergency valve must go fully closed or fully open when required, using a force for this action that is not affected by other operating conditions, and which is sufficient to actuate the valve, overcoming the maximum differential. The most reliable of the available stored forces is either a spring or a dead weight. Stored pneumatic pressure or pressure of the flowing fluid are considered safe only for certain operations.

Valves actuated when flow exceeds a predetermined rate, or when pressure or temperature go above or below fixed limits, either (1) require sensing elements which release the stored energy or (2) utilize change in energy for actuation. In the former category are swing check valves in which a latch is released. Fig. 11-1 shows a latch-type valve in which an integral orifice is used as the sensing element for flow. Other valves use a fusible metal plug to sense over-temperature, or line pressure piped to diaphragms to furnish the force in case of over- or under-pressure (Fig. 11-2). To the latter category belongs the valve shown in Fig. 11-3, which automatically shuts off the supply in oil, water, air, or other lines in event of a break beyond the valve. Here the increased flow with the accompanied higher velocity will close the valve and hold the disc on its seat. The illustrated valve has an internal bypass. All these valves are manually reset.

Fig. 11-1. Excessive flow is sensed by integral orifice. Increased differential releases swing check.

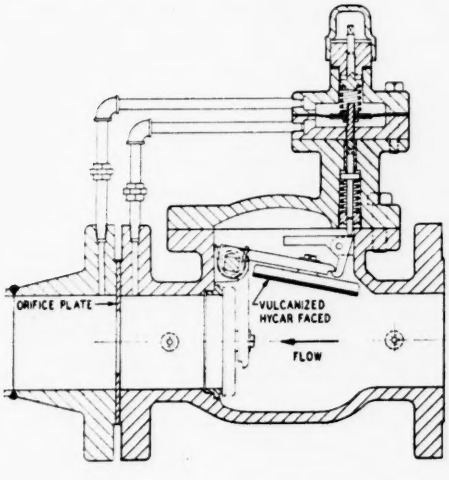


Fig. 11-2. When high or low pressure limit is exceeded, diaphragms actuate swing check.

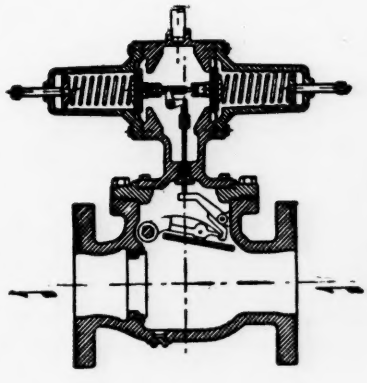
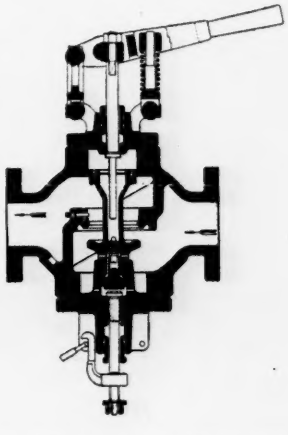


Fig. 11-3. Kinetic energy of uncontrolled flow, caused by break, closes valve.



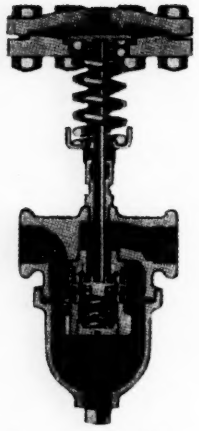


Fig. 11-4. Self-actuated shut-off regulator.

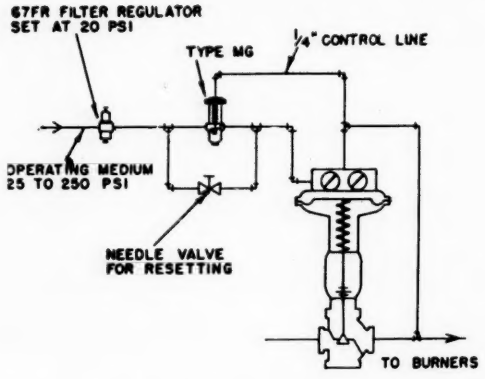


Fig. 11-5. Installation drawing of self-actuated regulator shows application as shut-off for supply pressure in event of fuel gas failure.

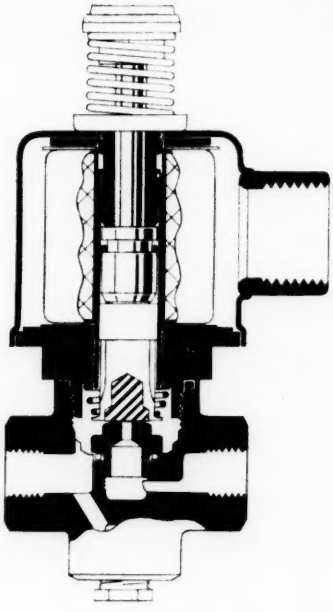


Fig. 11-6. Solenoid valve is held open by current. Manual opening is required to reset.

Another self-actuated shut-off valve (shown in Fig. 11-4) finds application (1) to lock the pilot output pressure on the diaphragm of a control valve in the event of plant air supply failure, or (2) to shut off the operating medium supply pressure to the controller pilot in the event of failure of fuel gas to burners (as shown in Fig. 11-5). To resume operation, the needle valve in the by-pass around the controller must be opened.

Current Failure

The valve which closes upon loss of electric current is the most frequently used type, especially for shutting off a fuel supply.

This type of valve can be actuated by the following conditions: (1) current failure to the valve or to part of the system which is important to normal operation, (2) main flame or pilot light failure, (3) abnormal fuel conditions, (4) failure of feedwater control system as indicated by high or low water level, and (5) excess temperature in heating system (as shown by water, air or steam indicators.)

Oil and Gas Valves

Specifications for valves handling heated or unheated fuel oils are included in the National Bureau of Standards Commercial Standards (C. S. 12-40). For approval, tests are required at temperatures of the fluid up to 250°F to simulate pre-heating which is necessary when firing heavy fuel oil.

Valves for emergency shut-off of gaseous fuels are identical with oil valves except for differences in trim. Softer seats can be used for gas, and materials which are not affected by sour (sulphur) gas may be required. Explosive conditions are created more rapidly with gaseous fuels so that faster closing may be advisable. Tight closure is more difficult to obtain with gas valves than with oil valves.

Solenoid and Electromagnetic Actuation

Solenoid-operated valves of a wide variety of designs are used frequently for safety shut-off. The valve shown in Fig. 11-6 can be opened manually by depressing the top. This causes two iron cores to meet and be held together by the magnetic field; when the manual force is removed from the top, the heavy spring lifts the lower inner valve off its seat. On loss of solenoid current the valve closes due to the weight of inner valve and lower core.

Other valves used are the electric-opening type (Fig. 11-7) in which the current lifts the assembly of solenoid core and inner valve off the seat. When correctly installed (in a vertical upright position) the valve closes on loss of current.

Any spring- or weight-loaded diaphragm control valve can be used as an emergency valve when suitable pilot operation is added. Spring-loaded valves of either the air-to-close or air-to-open type are suitable when solenoid valves operated by the emergency-sensing device are used to either release the pressure in the diaphragm case or to pressurize the case from a dependable source.

In most cases (at least with large size valves) a valve in addition to the control valve is used for emergency function. Valves are available (Fig. 11-8) which, in addition to being approved for shut-off, can be used for pressure or temperature control. These valves also can be set for minimum flow without interfering with the safety features. In event of loss of current or diaphragm rupture, pressure equalizes on each side of the diaphragm so that spring or weight will close the valve.

Solenoid operation may be used to trip a swing check (Fig. 11-9), allowing it to close the valve. Large globe valves may be controlled by using two solenoids (Fig. 11-10). The tripping mechanism may be set to close the valve either on energizing or de-ener-

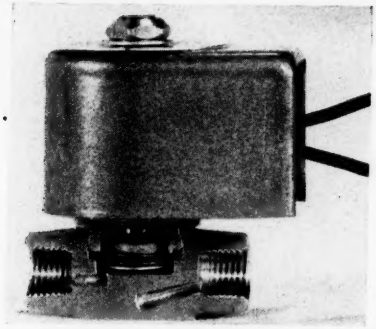


Fig. 11-7. This normally-closed solenoid valve is reset by resumption of current.

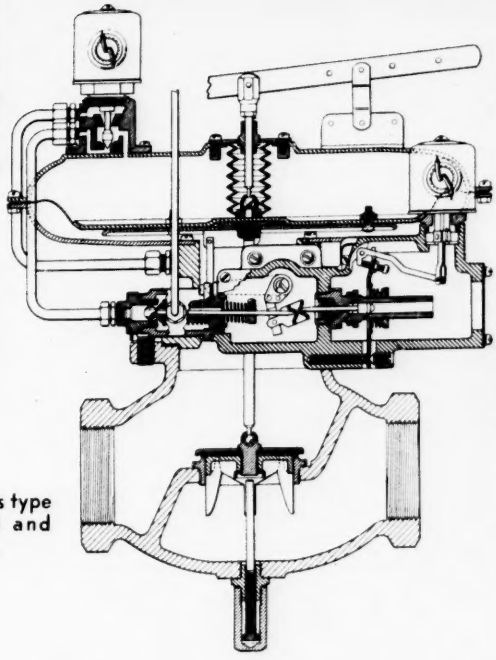


Fig. 11-8. Gas valve of this type is combination control and emergency shut-off valve.

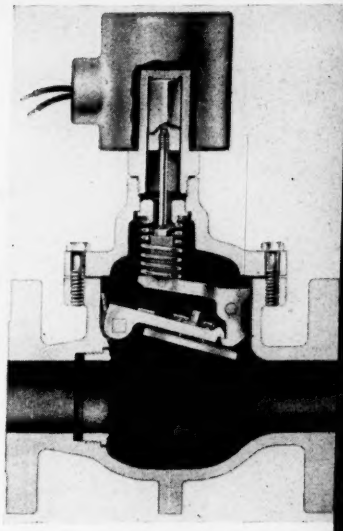


Fig. 11-9. Actuation of tripping mechanism closes swing check.

gizing the tripping solenoid. The valve cannot be reset without the unlatching solenoid being in proper position. Controlling switches are located on each side of the spring and are operated by a link from the lever.

Solenoid operation of a trigger pin (Fig. 11-11) will allow a spring-loaded valve to close. The unit incorporates a pressure release as well as an electrical trip. Fig. 11-11a shows open position with trigger spool lifted; Fig. 11-11b shows closed position. Release assemblies for various pressure ranges may be employed with this unit.

Operation by either of two pressures is accomplished by integrally connected pressure units as shown in Fig. 11-12. In the illustrated unit low-pressure air acts on the large (inner) diaphragm and high-pressure oil, gas, or steam on the smaller (outer) elements.

Solenoid force also can be used to operate the trip mechanism for releasing a spring-loaded valve (Fig. 11-13). The valve can be reset by the handwheel (when the electro-magnet is energized to hold the armature) or by handwheel crank, level or chain. Closing action is rapid until cushioned by compression acting on the piston moving with the stem. The

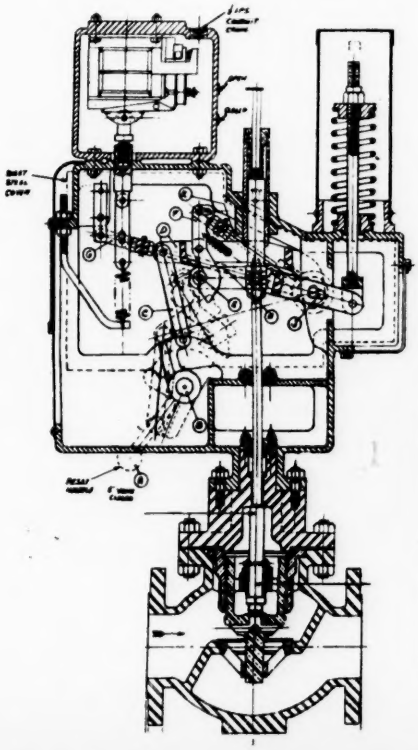
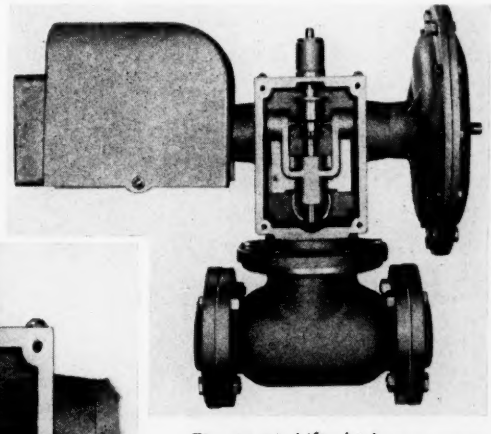


Fig. 11-10. Two solenoids control closing of globe valve.



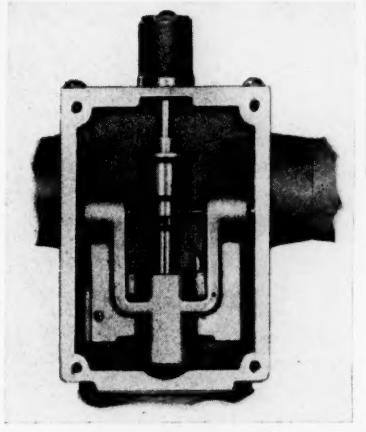


Fig. 11-11. Lifted trigger assembly holds valve open. Pins of lowered trigger assembly close valve (left).

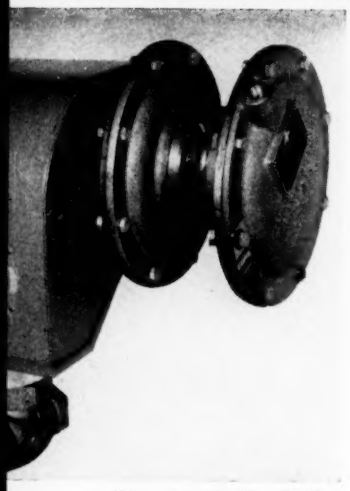


Fig. 11-12. Dual-diaphragm assembly to operate shut-off valve.

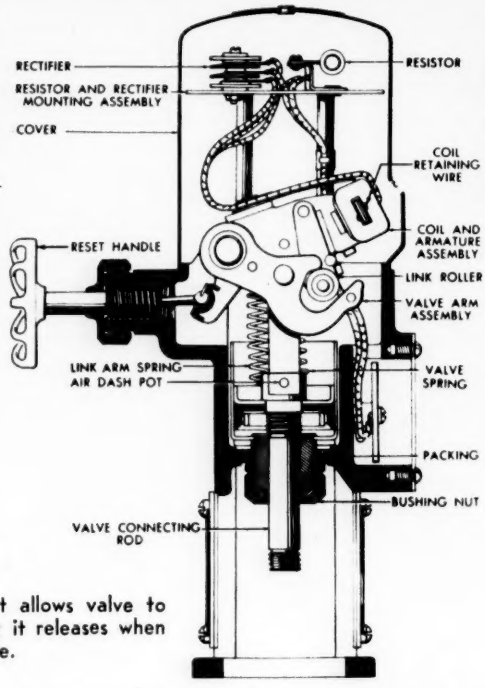


Fig. 11-13. Electro-magnet allows valve to be opened by handwheel; it releases when de-energized to close valve.

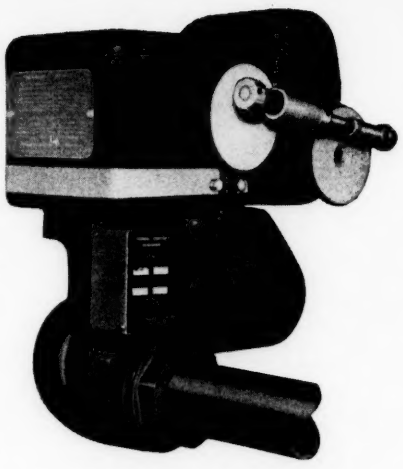


Fig. 11-14. Spring return damper motor remotely positions valve.

unit is designed for all usual voltages, both ac and dc. Current consumption is low enough to allow actuation by a thermopile pilot generator.

Remote Actuation

Many manually-operated shut-off valve actuators can be motorized to accomplish remote opening. For instance, a standard damper motor (Fig. 11-14) can be mounted integrally with the valve to accomplish this. The electrohydraulic unit shown in Fig. 11-15 incorporates this feature inherently. The actuator is an oil-immersed motor-driven pump causing hydraulic pressure to drive a piston. A relay-operated spill valve releases pressure on the piston for spring return. Use of two relays allows for closing the valve in normal operation when controlling flow with the second relay unloading rapidly for emergency shut-off. Operation of the relay has been reversed and isolated for automatic or manual remote operation from a d-c emergency battery circuit.

Motor-operated gear-driven actuators are normally considered as non-current-failure units. That is, on current failure they remain in the last held position. Nevertheless, many of the smaller units are designed for spring return. They do not readily adapt themselves to emergency shut-off because they must, in most cases, reverse their motion, requiring the spring to run the gears in reverse.

Many valves have been designed expressly to sense either excessive or insufficient pressure. In these units movement of a diaphragm will cause a stem to operate a clasp whereby a spring- or weight-loaded valve will close. The valve may be of the globe type (like Fig. 11-8) or the swing check style of valve like Fig.

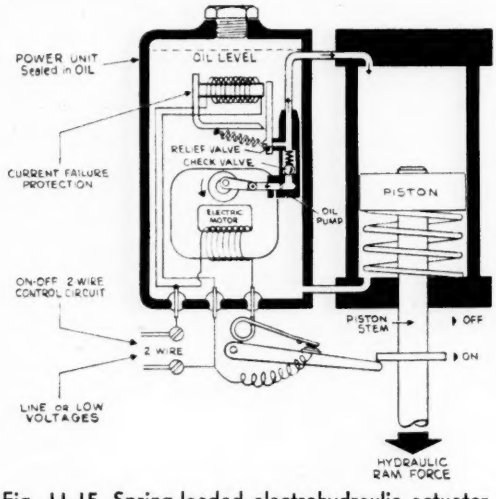


Fig. 11-15. Spring-loaded electrohydraulic actuator closes valve when relay-operated spill valve opens.

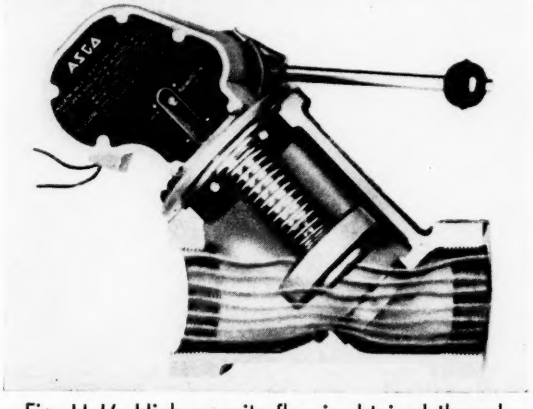


Fig. 11-16. High-capacity flow is obtained through "S" body.

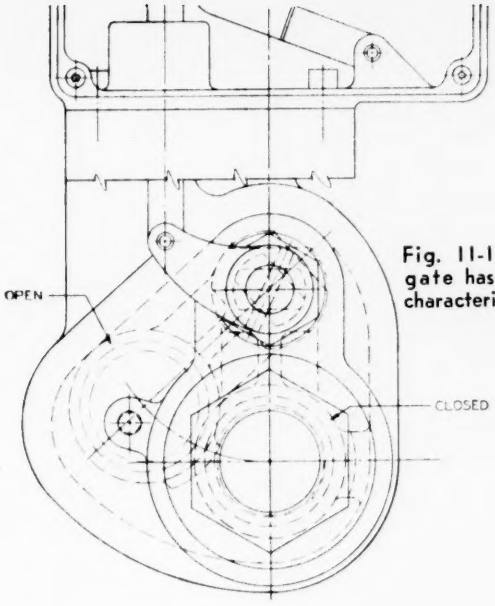


Fig. 11-17. Swing gate has full-flow characteristic.

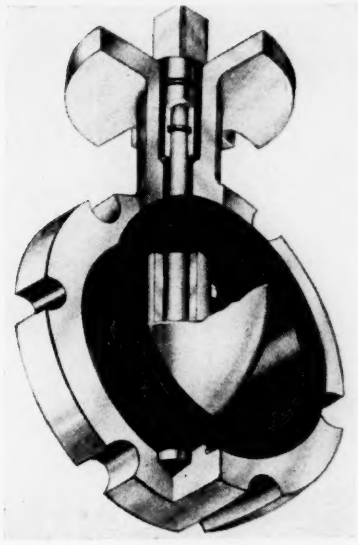


Fig. 11-18. Positive shut-off is possible when using rubber seals.

11-9). In another valve design, movement of the diaphragm will release a weighted cam which swings into a position where the stem is held down until manually released. Most of these valves may be set to operate upon over-pressure, under-pressure, or abnormal change in differential pressure.

Valve Bodies

Globe-type valve bodies predominate for emergency shut-off service. As positive shut-off is required, composition or "soft" discs are used. Unless the valve is used for control in addition to shutoff, the inner valve is flat and quick-opening. Except for large valves it is not necessary to have the inner valve top-and-bottom guided. A swivel or ball-and-socket joint between the stem and inner valve allows the inner valve to find its seat. Many of these valve bodies are packless to minimize packing friction that might hinder closing. A valve that is installed for emergency shutoff only must not cut down flow in the system. For this reason globe valves used for this service are usually over-ported. The "S"-*type* body (Fig. 11-16) offers less restriction to flow than the "straight-through" globe body.

Swing-check design offers little or no restriction to flow. Seating surfaces which are vertical (or close to a vertical position) do not tend to accumulate dirt. However, this type of body tends to fail in closed position if operating links or triggers fail. Opening mechanism must be designed adequately for opening under maximum-unbalance pressure conditions.

Gate valves (Fig. 11-17) of the swing type offer full-flow characteristics. Gates which seat in a groove are not considered adequately positive for emergency shut-off. Gates that slide between two seating surfaces and depend upon this contact for tight shut-off have been passed by approval agencies. Although this type of valve tends to be self-cleaning, design and materials of the seating surfaces are critical for continuous service.

Butterfly valves with rubber or composition liners or soft seat rings (Fig. 11-18) are suitable for positive shut-off. The type shown has been used successfully under high vacuum. Although these valves do not seem to have been submitted to the approval agencies, they are worthy of consideration for the service. The flow at full opening approaches that in an open pipe.

Temperature-actuated Valves

Most temperature shut-off valves are triggered by temperature-sensing devices. An important application for a shut-off valve is to discontinue fuel supply to an engine upon increase in jacket water temperature or decrease in oil pressure. An integrated system for this service closes a switch under unsafe water or oil conditions. Closing the switch applies magneto current to a coil that releases the swing check disc of the valve (Fig. 19).

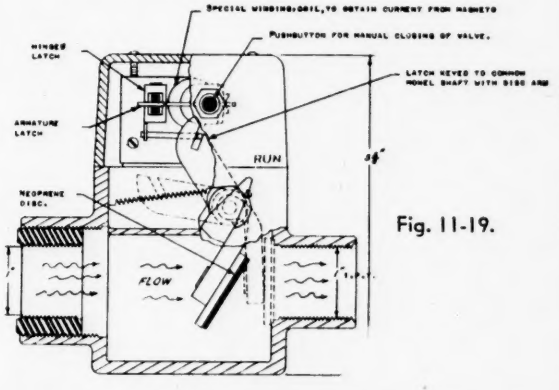

SPECIAL WINDING: 600 TURNS, TO OBTAIN CURRENT FROM MAGNETO
PUSHBUTTON FOR MANUAL CLOSING OF VALVE.
HINGED LATCH
LATCH KEYED TO COMMON MONEL SHAFT WITH DISC ARM
ARMATURE LATCH
RUN
NEOPRENE DISC.
FLOW

Fig. 11-19.

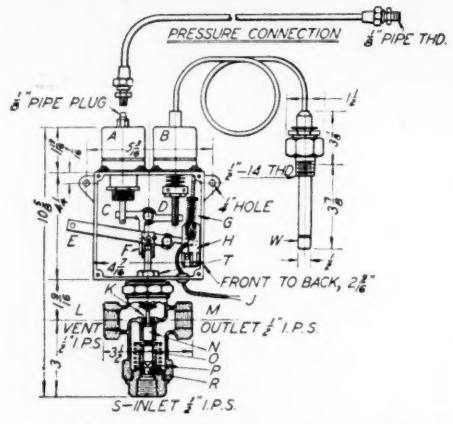


Fig. 11-20. Pressure and/or temperature elements trip valve.

The same protection is obtained by a valve shown in Fig. 11-20. Either abnormal temperature increase or a pressure decrease will release the trigger to allow spring-closing. An alarm switch may be added to call attention to the shut-down.

Sensing the temperature of a pilot light is used to shut off fuel on loss of flame. Line gas pressure is used to make the valve (Fig. 11-21) a self-operating shut-off valve. Operation of the pilot valve by current developed by a thermopile heated by the flame makes the operation of this valve independent of an external power source. The valve closes upon interruption of the flame at the pilot. A spring closes the valve when pressure on both sides of diaphragm is equalized.

All the care that has gone into the design and testing of valves for emergency shut-off service can be nullified by careless installation or lack of maintenance and periodic testing. Attention to installation instructions, adequate blowing out of piping, selection of location of the valve and of routing of wiring for protection, are all vitally important.

Supervising Agencies

Numerous approval agencies, both national and local, concern themselves with setting standards for safety shut-off or self-closing valves. One of the most important agencies is Factory Mutual Laboratories of Associated Factory Mutual Fire Insurance Companies. FM (for short) carries out tests of both "manual-opening" and "automatic-opening" valves submitted to it for approval. Whether the valve is manually or automatically opened, actuation must not be possible unless the holding medium is applied. FM stipulates closing of the valve within five seconds. Many valves can be closed in much shorter time for use on more critical installations. The valve actuator must be suitably enclosed and so designed that it cannot be by-passed readily or blocked open. Blocking the handle of a manually-operated valve must not prevent closing when the holding medium is cut off.

Another approval agency is Underwriters' Laboratories (UL for short) maintained by the National Board of Fire Underwriters which approve equipment used in industrial and home installations.

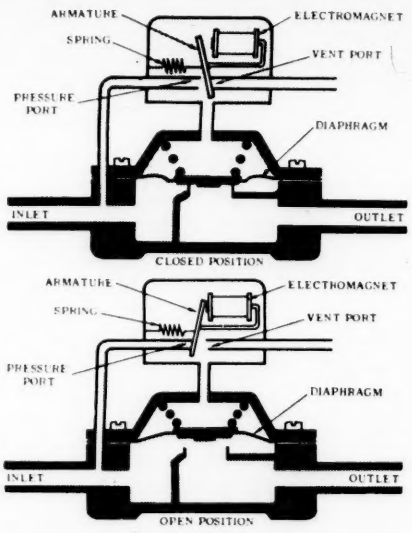


Fig. 11-21. Current from thermopile positions pilot valve. Equalizing diaphragm pressure allows spring closure.

FM-Approved Types

The following manufacturers are included in the list of those furnishing equipment which has been approved by Factory Mutual for the services discussed:

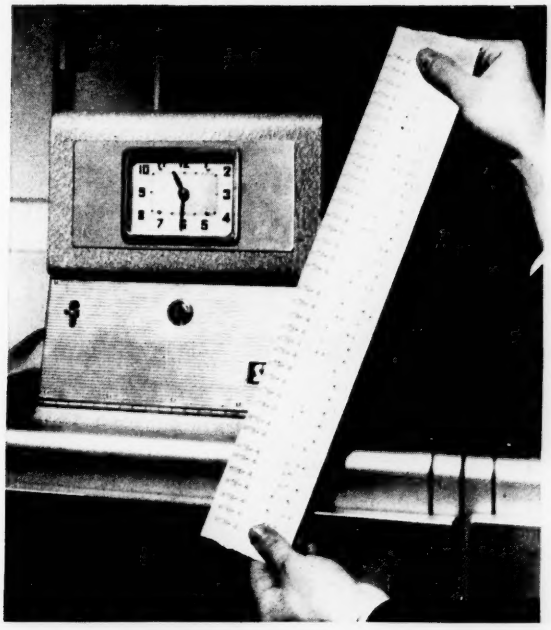
Automatic Switch Co.	Hauck Mfg. Co.
Bailey Meter Co.	Magnatrol Valve Corp.
Barber-Colman Co.	Mason-Neilan Div.
Barksdale Valves	Maxon Premix Burner Co.
Bryant Industrial Products	Mercoid Corp.
Clayton Mfg. Co.	Minneapolis-Honeywell
Combustion Control Div.	North American Mfg. Co.
Detroit Controls Corp.	Orr and Sembower, Inc.
Eclipse Fuel Eng. Co.	Petro
Fisher Governor Co.	Webster Electric Co.
General Controls Co.	Western Products Inc.

Additional companies furnishing equipment which do not fall within the scope of this approval agency are:

Coppus Engineering Co.	Frank W. Murphy
Fulton Sylphon Div.	Ruggles-Klingeman Mfg. Co.
Robertshaw-Fulton Controls	Schutte & Koerting Co.
Keystone Mfg. Co.	Security Valve Corp.

Acknowledgement

Pictures are by courtesy of Automatic Switch Co. (Figs. 11-7 and -16); Coppus Engineering Co. (Figs. 11-1 and -9); Eclipse Fuel Engineering Co. (Fig. 11-11); Fisher Governor Co. (Figs. 11-4 and -5); Fulton-Sylphon Div. (Fig. 11-20); General Controls Co. (Figs. 11-6, -8, -13, -15, -21); Keystone Mfg. Co. (Fig. 11-18); Maxon Pre-Mix Burner Co. (Fig. 11-14); Frank W. Murphy Co. (Fig. 11-19); North American Mfg. Co. (Fig. 11-12); Ruggles Klingeman Mfg. Co. (Fig. 11-10); Schutte & Koerting Co. (Fig. 11-3); Security Valve Corp. (Fig. 11-2); and Webster Products Inc. (Fig. 11-17)



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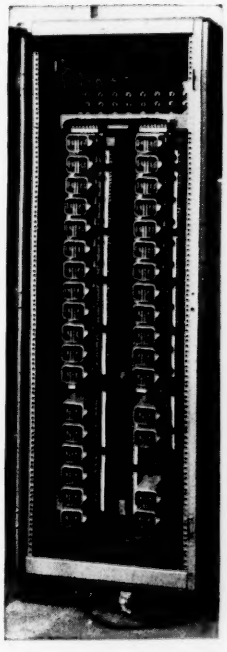
Relay rack (right) holds Panalarm plug-in relay units for Recording Annunciator.



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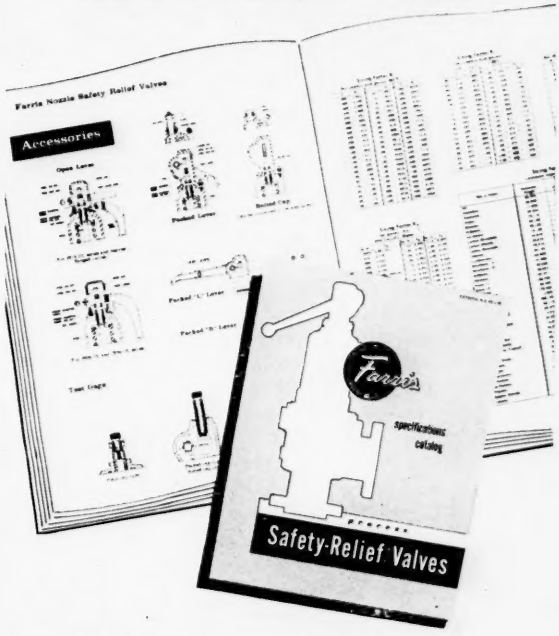

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Journal of the S C M A . . .

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Regulation Pitfalls

Inadequate design of gas handling stations is caught by analyzing combinations of extreme conditions. All pressure losses in a system must be considered at these extreme conditions.

W. L. MASHETER

WHAT causes mistakes in the design of gas handling stations involving pressure regulators? Some of the causes are:

1. Inexperience
2. Inadequate training
3. Carelessness
4. Incomplete data on functions to be performed.

In regard to the fourth, most engineers agree that a thorough understanding of the problem itself is a big step toward the solution.

There is another factor which causes inadequate design. In most cases the instrument engineer is trained and experienced in the computation of capacity, in the effect of critical flow, methods of computing pressure losses across a fitting, valve, etc., and is thoroughly acquainted with the operation of the equipment selected. Yet, apparently due to not putting all of these factors together properly, he comes up with a design that will not do the job intended. The following two examples illustrate this point; the drawings are flow diagrams of actual designs.

Residential Load

The first design (Fig. 1) is for a meter and regulator station to supply a residential distribution system serving approximately 3000 homes. Standby regulation of 100% is required in event of failure of one of the regulators. The computed maximum flow is 140 mcf/hr at 100-psig maximum and 45-psig minimum inlet pressure; 15 psig is the pressure to be supplied to the distribution system.

A 4" orifice meter is found to have a capacity of 160 mcf/hr at 40-psig 90"-W.C. differential with a maximum allowable orifice plate. A 2" regulator of a certain type and make is found to have a capacity of 145 mcf/hr at 45-psig inlet and 15-psig outlet. The computations indicate that the regulator is operating in its critical flow range. Past experience has shown that downstream plug valves the same size as this particular make of regulator are inclined to have high pressure losses, but at critical flow this will not be of any consequence.

What is wrong with this design? In the first place, the regulator does not have 45-psig inlet pressure when the inlet pressure is at a minimum. A flange-type primary orifice meter which will produce 90"-W.C. differential will have an over-all pressure loss of 46"-W.C. The 4" inlet and outlet valves on the orifice meter are found to produce a combined pressure loss of 12"-W.C. Computed pressure loss for miscellaneous fittings is 9", and the pressure loss across the 2" inlet valve is computed to 30"-W.C. This makes a total of 97"-W.C., or 3.5-psi pressure loss before the gas gets to the inlet of the regulator.

Presented at Seventh Annual Instrument Short Course at Los Angeles Harbor Junior College, Jan. 30-31, 1958.

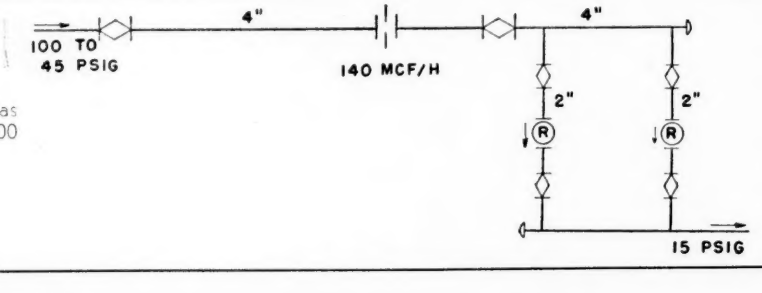


FIG. 1. DESIGN of actual gas regulating station serving 3000 residences.

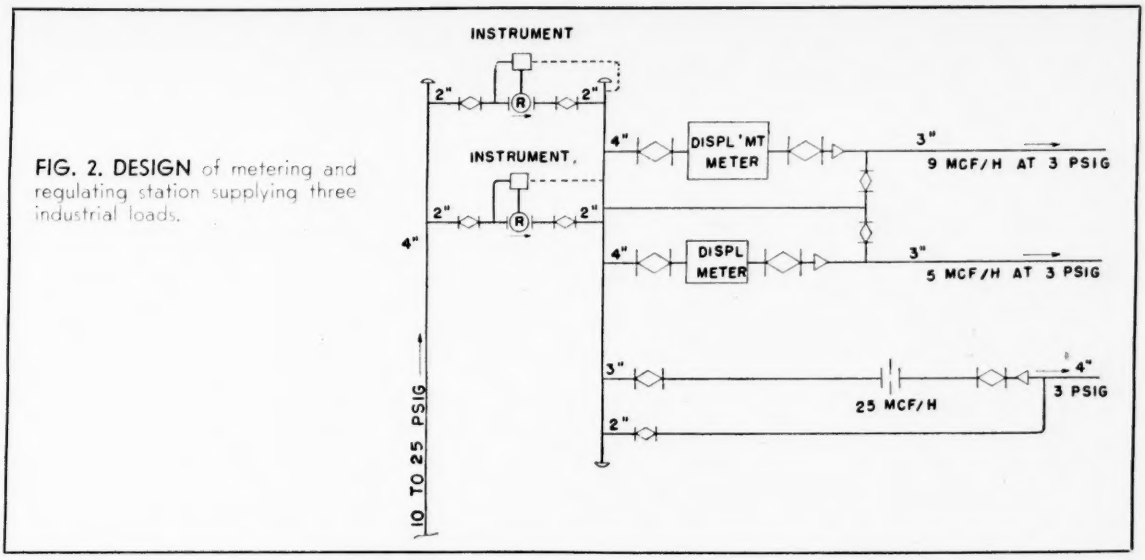


FIG. 2. DESIGN of metering and regulating station supplying three industrial loads.

Since the original computation for regulator capacity shows that the regulator was barely at the critical flow point, this loss in inlet pressure and the loss across the outlet valve throws the regulator below the critical range point. Therefore the pressure loss across the outlet valve cannot be neglected; the computed loss across the 2" outlet valve plus fittings is 3.1 psi.

Recomputing the capacity of the regulator at 41.5-psig inlet and 18.1-psig outlet, the capacity is now only 134 mcf/hr. This does not miss the 140 mcf/hr required very far. However, let us see what will happen assuming a cold morning, 45-psig inlet pressure, 140-mcf/hr load, and one of the 2" regulators stuck closed. What is going to happen to our distribution system?

The capacity of a regulator closely follows the formula $Q = C\sqrt{Ph}$, where P is the outlet pressure in psia and h is the pressure loss across the regulator in psi. With a constant inlet pressure (56.5 psia), reducing the outlet pressure to less than half the absolute inlet pressure does not increase the capacity of the regulator. Therefore, assuming that atmospheric pressure is 15 psi, the maximum is reached at 13.25 psi outlet pressure. However, under these conditions the capacity of the regulator is only 137 mcf/hr. Therefore some customers at the end of the distribution system are not going to get enough gas; some pilots may go out. This station has not met its design requirements.

JULY MEETING:	Thursday, the 17th, Rio Hondo Country Club, Downey California.
FEATURE:	Panel Discussion of Column Control. Speakers: M W Adcock, Union Oil Co of California; R A Robinson, The Fluor Corp, Ltd; E H Reynolds, Richfield Oil Company. Chairman: A J Fink, Taylor Instrument Companies.

Industrial Load

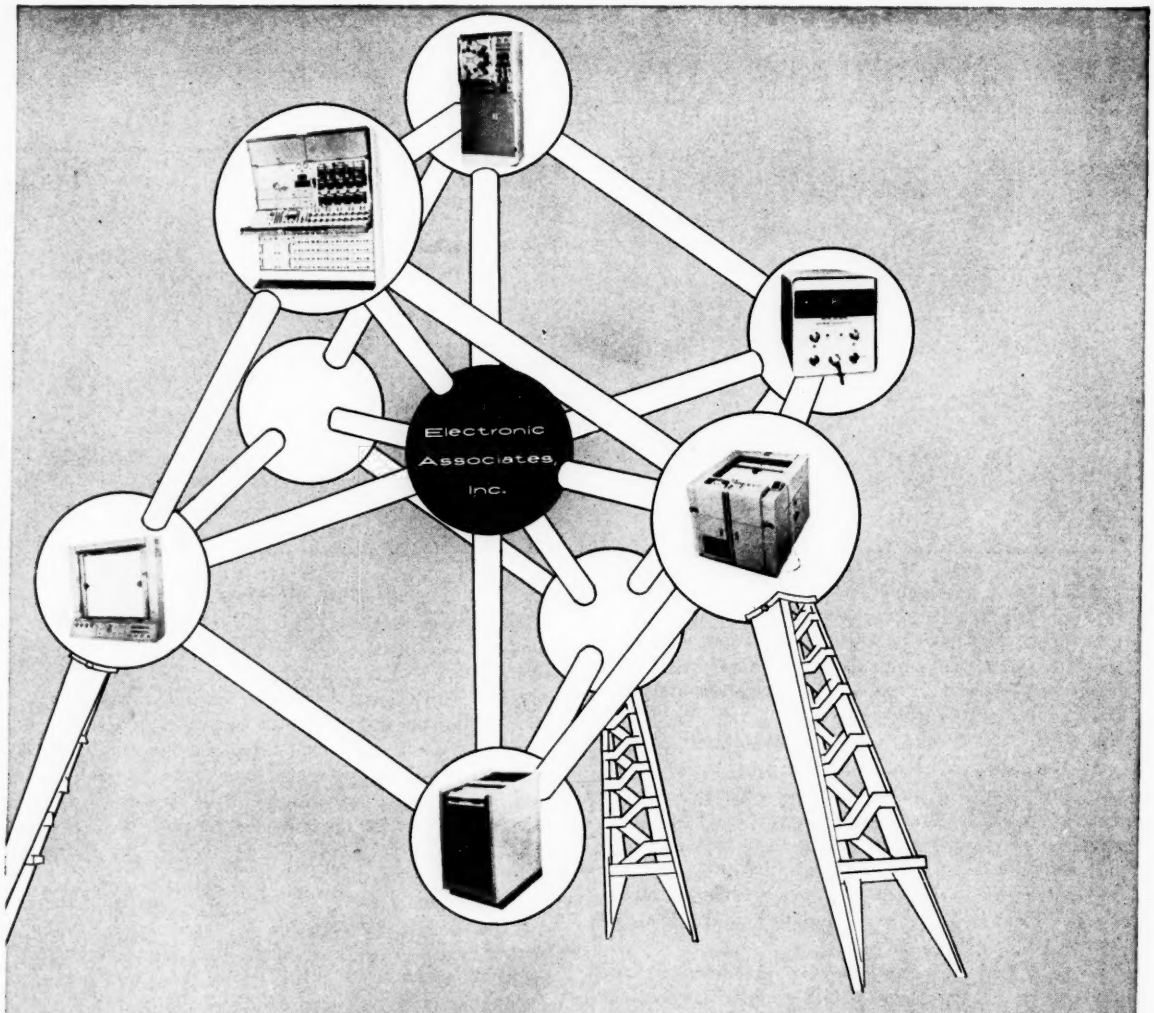
The second example (Fig. 2) is for a meter and regulator station to supply gas to three separate industrial loads. The minimum inlet pressure is 10 psig, the maximum 25 psig. The loads (as shown on the flow line sketch) are all to be supplied at 3 psig to the customer's lines. This design has the same fault as discussed before; the inlet and outlet valves produce a considerable pressure loss. However, the standby regulator is not intended to give 100% protection in this case. Larger valves improve the design and the situation is not serious.

At first glance, the 3" valves and 3" orifice meter look a little strange alongside 4" valves for loads in the order of 1/3 and 1/5 of the load going through the 3" valves. A check on the size of the orifice meter shows that it is just large enough with a 40"-W.C. differential across flange connections. This 40"-W.C. will produce an over-all loss of approximately 20"-W.C. The combined pressure loss across the two 3" valves and the accompanying fittings is 5"-W.C. This, plus the orifice-meter loss equals 25"-W.C., or nearly one psi. Therefore, at maximum 25 mcf/hr load the customer is only going to have a little over 2 psig on his line instead of the required 3 psig.

The control of the regulator could be extended to this plant line, but this would cause a variation in pressure on the other two lines because the 25 mcf/hr load is not constant. This extra pressure and variation in load may not hurt the customer, but it will reduce the accuracy of measurement through the displacement meter.

The prize boner is that the instruments for controlling the regulators require at least 15-psig supply pressure—but at minimum inlet pressure they will have only 10 psig.

The above two illustrations show what can happen when *all* of the pressure losses in a station are not taken into consideration. They also show the results of considering the various facilities separately rather than as a part of an over-all design.



Equipment pictured:
(Clockwise from bottom)
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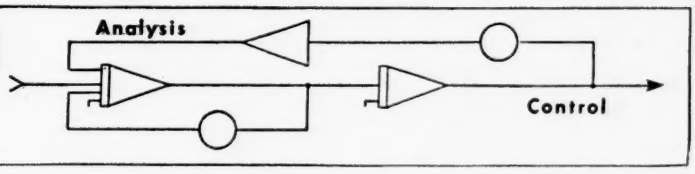

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Bits

Two meeting reports—and not much else—make up this month's *Newsletter*.

At the meeting held by the Southeastern Simulation Council in February, "Application of Flow Graphs to Analog Computer Programming" and "An Evaluation of Series Summations on the Analog Computer" were the topics of discussion.

The original report of these talks was *Ed Holmes'* version of the speakers' presentations. The writeup here is my liberal interpretation of the Holmes' version. So any similarity between the *Newsletter* writeup and the speakers' presentations, though definitely intended, is more to be sought for than expected.

If my distorted presentation of *Mr. Ireland's* mathematical jujitsu throws you, I refer you back to the source of the technique, and suggest that you go on to *Jerry Kennedy's* comparatively unmolested report of the April meeting of the Midwestern Simulation Council. Although on a very complex subject, Jerry reports the meeting in an interesting and readable style. If you *must* get complex, references are given.

Pieces

SOUTHEASTERN SIMULATION COUNCIL MEETING OF 28 FEBRUARY

The Georgia Institute of Technology was host to the Southeastern Simulation Council meeting held on 28 February 1958 in the Wilby Room of the Georgia Institute of Technology Library.

Hammond on Flow Graphs

Robert S. Johnson, Chairman of the SESC, introduced the first speaker, *Joseph L. Hammond* of the Georgia Tech Electrical Engineering Department staff. Mr. Hammond, who spoke on the "Applications of Flow Graphs to Analog Computer Programming," introduced his subject with a brief review of flow-graph techniques. These were originally developed by S. J. Mason and described by him in the September 1953 *IRE Proceedings*.* Since that time the use of flow graphs has become widespread in the analysis of feedback amplifiers and servomechanisms. Recently, several authors have advocated the use of flow graphs in programming analog computers. At least one of these has pointed out the relation between a flow graph and an analog computer set-up diagram and has shown how a computer might be wired directly from a flow graph. Mr. Hammond's paper suggested several ways in which the use of flow graphs can give insight into some of the problems associated with programming an analog computer.

Any discussion of the application of flow graphs must be prefixed by calling attention to the fact that the algebra of flow graphs as developed was subject to the restrictive condition that the equations represented by the flow graphs must be linear ordinary differential or linear algebraic equations. This restriction also applies to the techniques described by Mr. Hammond.

The established formalism of flow graphs is such as to make them applicable to computer work. First a flow graph is obtained for the equation or group of equations to be programmed on the computer. Second, use is made of the algebra of flow graphs either to reduce the flow

*In his article, "Some Properties of Signal Flow Graphs," Mr. Mason shows that the equations characterizing a systems problem may be expressed as a network of directed branches connected at nodes. He then shows that the topology of these flow graphs exposes the structure of the associated functional relationships and develops manipulative techniques by which the graphs may be transformed or reduced, thereby solving, or programming the solution of, the equations. The algebra of linear flow graphs is also explained.

graph to a more suitable form, or to perform certain tests which may show up potential sources of computing errors. Having performed one or more of these operations on the flow graph, the computer is then programmed directly from the flow graph or from a conventional computer diagram which can easily be derived from the graph.

Mr. Hammond used two specific examples to show how flow graphs can be used to reduce the number of computing elements. The first demonstrated the elimination of unnecessary variables; the second illustrated how the number of amplifiers may be reduced by the use of passive elements.

Finally, he showed that flow graphs can be used to spot certain types of extraneous roots which may be introduced by the computer. Several authors, notably *L. G. Walters* and *N. R. Scott*, have called attention to the fact that if the number of integrating amplifiers used in simulating a given set of equations exceeds the degree of that set, there is a possibility that the errors caused by normal computer tolerances will be excessive. In particular it is possible that extraneous characteristic roots may be introduced. These roots may be in the right half of the complex s-plane, in which case they can dominate the behavior of the computer. Mr. Hammond therefore demonstrated the use of flow graphs to develop a test for the presence of such right-half-plane roots.

Asked by *Bob Johnson* if it is possible to handle initial conditions with flow graphs, Mr. Hammond replied, "Yes, initial conditions would enter the equation in the same manner as the forcing functions."

Ireland on Evaluation of Series Summations

Following Mr. Hammond's talk Bob introduced *Mr. H. M. Ireland* (Engineering Experiment Station, Georgia Tech), whose paper was entitled "An Evaluation of Series Summations on the Analog Computer."

Mr. Ireland said that there are several types of problems arising in engineering and scientific work which require the evaluation of series summations. This is particularly true in waveform studies, diffraction studies, and similar investigations. In those cases where there is no convenient mathematical technique for the evaluation of a given series, we usually resort to some sort of automatic computing machinery. Methods for determining summations of the type:

$$(1) \quad f(t) = \sum_{n=0}^{\infty} A_n Q(n, t)$$

on digital computers are well known, but little has been said about the application of analog computers to this problem. Mr. Ireland described one analog-computer method for the approximate evaluation of series of this type.

You will note that f(t) of Equation (1), although properly a function of t alone, is also concerned with the *discrete* variable n. The analog computer method to be discussed consists of assigning a particular value, T_m, to t and then taking A_n and $Q_{Tm}(n)$ to be continuous functions of n. Then the continuous function is sampled as n takes on the desired discrete values in succession, and as many samples as are needed to give a good approximation are summed. As the assigned value of $t = T_m$ is arbitrary, the summation may be re-evaluated at as many points as desired and plotted against time (Figure 1) to produce a graphical representation of equation (1).

The instrumentation of the scheme which Mr. Ireland described is as follows: Consider the factors A_n and $Q_{Tm}(n)$ to be continuous functions of the *continuous* variable n, and to emphasize this write the terms of the series as:

$$(2) \quad f(T_m) = A(n)Q_{Tm}(n)$$

Now if we let n = "computer time" we can generate the factors A(n) and $Q_{Tm}(n)$ in the analog computer as continuous functions of n for each T_m, then multiply them together to form the product $A(n)Q_{Tm}(n)$. Keeping in mind that the variable n is equivalent to computer time, we sample the generated function at the points where n = 0, 1, 2, 3, ... and store the sampled values in an accumulator. After a sufficient number of samples (corresponding to a large number of terms in the summation), the value of the function at the chosen value of the argument T_m will be very closely approximated. Since the sampling and accumulation can proceed very rapidly, only a moderate amount of time is required to evaluate the function at a number of points. These functional values can be connected by a continuous curve to approximate the waveform of f(t) as a continuous function of t, as shown in Fig. 1.

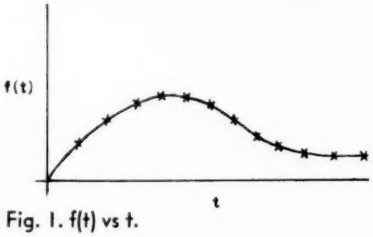


Fig. 1. f(t) vs t.

A block diagram of a computer circuit to perform the above operations is shown in Figure 2. The computer independent variable is taken equal to n, so each integrator in the blocks generating the factors A(n) and $Q_{Tm}(n)$ is operating with respect to n.

The block diagram can be divided into two parts: The standard computing components, and the special circuits required for the sampler and accumulator.

The generation of the factors A(n) and $Q_{Tm}(n)$ usually can be accomplished by standard components, depending on the nature of the functions. Diode function generators are useful where the functions have been empirically determined, and time functions generated by solving differential equations often can be used where the functions can be easily obtained on the analog computer. Many of the more common factors like sinusoids, exponentials, etc., are amenable to analog generation.

The switching for the sampler in most cases necessitates adding some accurately-timed switching device. In Mr. Ireland's computer laboratory they utilize a unit developed by a member of the group which operates a relay periodically at preset intervals, from three samples per second to one sample every 13.5 seconds. This device uses a Berkeley preset decimal counter unit and is

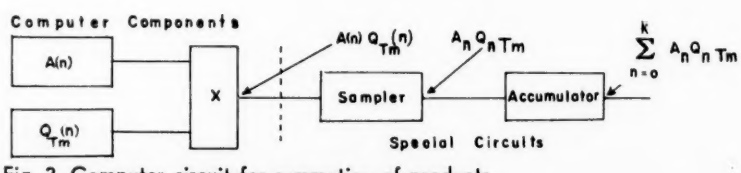


Fig. 2. Computer circuit for summation of products.

capable of accuracies in switching time of better than 0.1 percent. For most cases accuracies this great are not necessary; however, the error in sampling time is additive and if a large number of samples are to be made the error may become large.

To illustrate the technique Mr. Ireland explained a problem in single-sideband reception now being studied in the Georgia Tech Analog Computer Laboratory. In this investigation the following summation appeared:

(3):

$$\sum_{n=0}^{\infty} \frac{1}{2n+1} \cos (2n+1)\,\omega t$$

Now it will be seen that this is a summation of the form of Equation (1), where $1/(2n+1)$ corresponds to A_n and $\cos (2n+1)\,\omega t$ corresponds to $Q(n, t)$.

Therefore we can make the changes of variables (i.e. let n = machine time and $\omega t = T_m$) as we did with Equation (1) and get

$$(4) \qquad f(T_m) = \sum_{n=0}^{\infty} \frac{1}{2n+1} \cos (2n+1)\,T_m$$

$$(5) \qquad f(T_m) \approx \sum_{n=0}^{K} \frac{1}{2n+1} \cos (2n+1)\,T_m$$

where K is the number of terms necessary for the required accuracy.

Now if we let $\theta = (2n+1)\,T_m$

$$\text{then } \frac{d\theta}{dn} = 2T_m$$

and Equation (5) might be generated as shown in Figure 3.

The limit on n has been changed from ∞ to k, and k may be any reasonable number required to give the desired accuracy.

When one operation is complete, i.e., when $n = k$, one point of the desired waveform has been generated. The time required to obtain one point depends upon the number of samples to be taken, and the sampling rate, which in turn is determined by the speed of the sampling device and the time required to generate the A (n) and $Q_{Tm}(n)$ terms. In the example, about 30 seconds are required for each point.

The type of sampler and accumulator used was suggested by *M. D. Prince* (Federal Telecommunication Laboratories, Atlanta, Ga.), and is shown in figure 4.

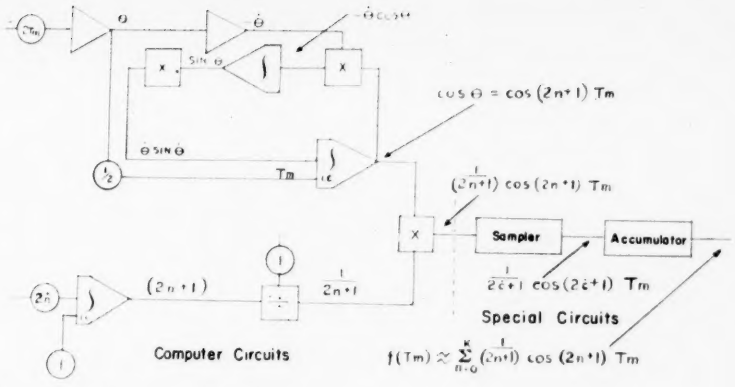


Fig. 3. Practical computer circuit.

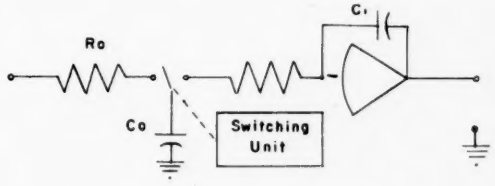


Fig. 4. Sampler and accumulator.

The time constant R_0C_0 and R_1C_1 must be made small compared to the switching rate so that the capacitors are charged to their final values when the switching action occurs. When the analysis is complete the function may be set up on a diode function generator and used as required in a problem.

The general shape of the curve obtained from the analysis used as an example is shown in Figure 5.

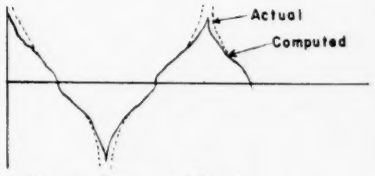


Fig. 5. Curve obtained.

As can be seen from these curves, the accuracy depends on the point being considered. Near $\pi/2$ the accuracy is very good, but the closer to 0 or π you get the greater the deviation becomes. In general, the accuracy will depend upon the particular problem.

The procedure described is applicable to many types of problems; it is limited primarily by the ability to generate the A(n) and $Q_{Tm}(n)$ terms and the accuracy required.

Tour of GIT

After Mr. Ireland's paper the members of the Southeastern Simulation Council were taken on a tour of the Digital and Analog Computing Facility of Georgia Institute of Technology.

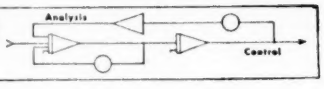
In the evening a dinner meeting was held in conjunction with the Atlanta Section of the AIEE. A technical paper by *J. H. Meeks*, entitled "Applications and Use of the Analog Computer," gave a basic résumé of the philosophy and application of analog computers.

MIDWESTERN SIMULATION COUNCIL MEETING OF 7 APRIL ON "SIMULATION OF AIRCRAFT GAS TURBINES"

About 74 members representing 20 different companies met on 7 April 1958 at Allison Division of General Motors in Indianapolis, Indiana to discuss "The Role of Electronic Analog Computers in the Simulation of Aircraft Gas Turbines." Prior to the technical meeting members and guests toured Powerama, an exhibit of Allison products. There were cut-away models of jet engines, turbo-compound engines, and many other components which go to make up modern aircraft propulsion systems. And outside the main engineering lobby there was a full-scale model of a vertical take-off and landing (VTOL) aircraft with a turbo-compound engine.

The Simulation Council was given

SIMULATION COUNCIL



official greeting by *R. E. Settle*, Executive Engineer of Experimental Operations, Aircraft Engineering Department. Mr. Settle questioned the members, wanting to know who was minding the store while they were out attending this highly technical meeting.* Later he was assured by *Max Sayler* (General Electric, Evendale, Ohio) that there were lots of engineers minding the store while these few were attending the Midwestern SC meeting.

Hietbrink on Dynamic Check

The first speaker was *E. H. Hietbrink* (Allison Division, General Motors), who discussed "Dynamic Check of Turbo-Prop Engine Simulation." Mr. Hietbrink pointed out that in recent years the electronic analog computer has been used extensively in the development of engine control systems. Through simulation the analog computer has been a great asset to the engine control designer. By using a simulated engine based on predicted compressor, combustor, turbine, and nozzle performance characteristics, the control designer can be ready with a reasonable control when the prototype engine runs. After the prototype engine has been run, more exact performance data are available and the simulated engine can be used to obtain an optimum control system for the particular engine. To the control designer this may mean making only small changes or adjustments on his previously-designed control. Mr. Hietbrink's discussion dealt primarily with using a simulated engine as an aid to obtain an optimum control system.

When developing a control system, the control designer wants to simulate as closely as possible the exact dynamic characteristics of the engine. This fact becomes more important as the control engineer strives to optimize the control system. While it is not at all uncommon to find that a control system which was stable on the simulated engine requires minor adjustments when installed on the actual engine, the desirable situation is that such adjustments be minimized. This can be achieved only if the simulated engine accurately represents the actual engine under all conditions of operation. Mr. Hietbrink's discussion included some methods of checking the dynamic characteristics of a simulated turbo-prop engine against experimental data, and he spoke of some of the fundamental problems and difficulties in obtaining a good simulation of dynamic characteristics.

The performance of a turbo-prop engine can be defined by the power section data from a dynamometer test. These are steady-state data and include corrected engine horsepower and turbine inlet temperature as a function of corrected engine speed and corrected fuel flow.

Reproducing these curves is accomplished with function generators of two variables. The type used in Allison's simulation were diode function generators driving servo-driven tapped potentiometers. The computer diagram was presented and is available in a technical report written by Mr. Hietbrink.

A fuel control, propeller control, and temperature control were simulated on the computer.

A dynamic check of a simulated engine was accomplished and consisted of three parts: (1) Checking the isolated engine without any controls; (2) Checking the engine with prop control; and (3) Checking the engine with both prop and fuel control. In the last two parts, simulated engine data were compared with experimental engine data and the results were quite satisfactory.

Sayler on Aircraft Propulsion Control

The next paper, given by *Max W. Sayler* (General Electric Co., Evendale, Ohio), was entitled "Summary of Aircraft Propulsion Control System Simulation At GE-Evendale." Max discussed the application of electronic analog computing equipment in the Controls Laboratory at GE-Evendale, explaining that at present they have a general-purpose computer consisting of:

- 370 operational amplifiers
- 14 electronic multipliers
- 13 servo multipliers
- 26 diode function generators
- 4 resolvers
- 34 channels of X vs. time recorders
- 2 X-Y recorders

In the main, this equipment is used for control system studies associated with jet aircraft engines to insure stable operation and adequate response of the engines. During the design phases the analog computer engineers work closely with the jet-engine design engineers and control system component manufacturers. In this way the controls are actually checked out on the computer to insure that they are providing optimum control under actual conditions. As the simulation progresses, actual controllers are tied into the analog computer until all controls have finally been substituted for the simulator.

In addition to the large general-purpose computing equipment, GE has a jet-engine simulator composed of five modules plus a control console. This special-purpose computer contains:

- 110 operational amplifiers
- 62 electronic multipliers
- 59 function generators
- 8 map readers (functions of two variables)
- 12 X vs. time recorders
- 2 X-Y recorders

The map readers are completely electronic and have practically no phase shift in the engine representation frequency spectrum.

Finally, there is a main speed drive unit with gear boxes which can be changed to suit the demand of the mechanically-driven elements and controllers. The combined facilities of the general-purpose computer, the jet-engine simulator, and the main speed drive occupy about 5,000 square feet of floor space. In addition to the above, they have nozzle discharge chambers for simulating the back pressure on the nozzles which actually occurs in the jet engine.

Larrowe on Dynamic Performance

The last talk, given by *Vernon L. Larrowe* (University of Michigan, Willow Run Research Center, Ypsilanti, Mich.), was a résumé of a paper entitled "Dynamic Performance Computer for Gas Turbine Engines," available from the University of Michigan. What were supposed to be copies of this paper, meant for distribution at the meeting, turned out to be copies of another University of Michigan paper called "An Application of a Gas Turbine Engine Performance Computer to a Twin-Spool Engine," so these were passed out instead.

Vern pointed out that there is a standard numbering system for aircraft gas turbine engines. It usually starts with a zero, although it could start with Number 1, and the numbers progress from the forward part of the engine to the rear. The first part is the air intake, then the com-

*Some people have questioned whether our meetings were highly technical!

pressor, next the burner; Station 4 is the turbine inlet, Station 5 the turbine, and finally No. 6 is the exhaust. Vern showed a computer block diagram of the way the information flows through the computer. This pointed up the real advantage of an analog computer because the flow of information through the computer was identical to that within the engine itself.

One of the most interesting parts of Vern's paper described the widespread use Willow Run Research Center makes of logarithm and antilogarithm function generators. Because of the large number of multiplications and divisions involved in steady-state jet-engine simulation, logarithms can be used to great advantage if the equations are written in logarithmic form. Thus, to multiply two numbers, the logs of these two numbers are added; to divide, the one quantity is subtracted. To generate functions of two variable, WRRC has over one dozen X-Y plotters converted to map readers. A probe is positioned as a function of the two independent variables over a semi-conductive surface, and the voltage picked up from the surface is a function of the probe position.*

In addition to their work on aircraft gas turbines, Willow Run Research Center has conducted several studies on automobile gas turbine systems.

Tour of Allison

Don Dresser conducted a tour of the Allison computer facility, which is under the direction of *Dr. Robert E. Henderson*, and which includes the following Berkeley equipment:

4	control consoles
190	operational amplifiers
12	servo multipliers
40	electronic multipliers
250	servo-set potentiometers
80	diode function generators
18	X vs. time recorders
2	X-Y recorders.

Thot

"Lots of people are afraid that the next war will be fought in outer space. As for us, we can't think of a better place."—*Changing Times*

I am for letting the computers fight it out. I've a veteran slide rule that will "volunteer."—*Ye Ed.*

*Sounds simple till you try to make a suitable semi-conductive surface. We have discussed this method more than once in past *Newsletters*, but were not aware that WRRC had perfected them to this extent. —*ED.*

Computer Events

Western Simulation Council

Date: 10 July 1958
Place: Hughes Aircraft Company
Culver City
California
Time: 1:00 PM
Subject: "Automatic Programming of a Simulator"
For further information, get in touch with Hans Meissinger, Hughes Aircraft.

Denver Research Institute

Dates: 24-25 July 1958
Place: University of Denver, Denver, Colorado
Subject: Fifth Annual Symposium on Computers and Data Processing
The symposium will emphasize Formalized Techniques, Systems Organization, Logical Design Techniques, Automatic Programming, Components and Devices, Digital Communications. For information write C. A. Hedberg, Electronics Div., DRI.

Association Internationale pour le Calcul Analogique

Dates: 1-7 September 1958
Place: Strasbourg, France
Subject: "Journées Internationales de Calcul Analogique"

Midwestern Simulation Council

Date: 8 September 1958 (tentative)
Place: Caterpillar Tractor Company
Peoria, Illinois
Subject: "Land Vehicle Simulation" (tentative)

National Simulation Conference

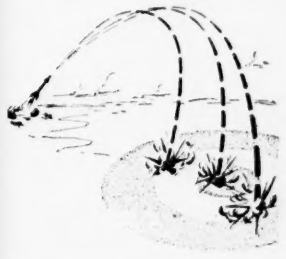
Dates: 23-25 October 1958
Place: Statler-Hilton Hotel, Dallas, Tex.
The conference will be sponsored by the IRE PGEC and the Dallas Section of the IRE. For further information write J. E. Howard, 2100 Menefee Drive, Arlington, Tex.

Eastern Joint Computer Conference

Date: December, 1958
Place: Boston, Mass.

ARE any new fields of computation opened up by the GPS High Speed Analog Computer?

YES, the statistical evaluation of the performance of systems perturbated by random noise can now be accomplished at high speed. With the system simulated on a



high speed computer such that the solution is carried out several thousand times faster than real time, samples of a random variable such as the miss distance of a missile system can be taken at rates up to 50 per second. Thus, sample sizes of several hundred can be taken in a few seconds' time.

GPS has a complete line of equipment to generate random noise for introduction to the system and to monitor the output. RMS values of random variables can be measured directly and complete probability distribution functions can be determined with statistical confidence in a matter of minutes.

IF you have problems requiring immediate analysis, the GPS Computer Center in Newton can provide analog facilities and experienced engineering assistance to suit your needs.

ANALOG COMPUTERS

GPS INSTRUMENT CO. Inc.
180 Needham Street
Newton 64, Massachusetts
DEcatur 2-8110

For more information circle **141** on inquiry card.

new instruments

CONTENTS OF THIS DEPARTMENT

Actuators 1093
Amplifiers 1091
Analyzers, Gas 1080
Annunciators, Alarms, etc. 1080
Computing and Data Processing 1076
Controllers 1080
Counting 1074, 1086
Data Processing 1076
Digital Systems 1068
Dimensional Gaging 1088
Electromechanical Components 1092
Electrical Components 1092
Electrical Instruments 1073, 1090
Electrical Instrument Accessories 1091
Electrical Testing 1090
Electronic Components 1092
Electronic Instruments 1090
Flow Rate 1083
Gaging 1088
Humidity 1082
Inspection 1088
LAST MINUTE ITEMS 1096
Mechanical Testing 1089
Miscellaneous 1095
Photography 1095
Pressure 1084
Process Analyzers, Monitors, Controllers 1080
Relays 1092
Scales 1085
Shop Equipment and Supplies 1086
Temperature 1082
Timepieces 1073
Vacuum 1084
Valves and Actuators 1093
Weighing 1085

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digital information systems

DIGITAL READOUT

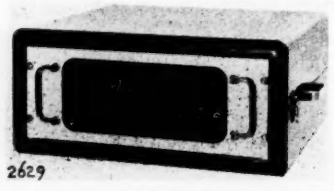
New Model 471 presents numbers on an easily-read single plane with no overlapping characters; employs a

simple projection system with 7000 to 8000 hours of lamp life. Display consists of 4 digits (decimal and 0 through 9) plus a symbol readout with symbols +, −, AC, NN, Ω, KΩ, MΩ, A/B, AC/B, AC/AC, X. Individual digits 1⅛" high; display area 2"h x 7.5" w. Special models have up to 9 individual readout units consisting of any desired combination of digits or symbols.—*Kin Tel, Div. Cohu Electronics, Inc.*, 5725 *Kearny Villa Rd., San Diego* 12, *Calif.*

For more information circle **213** on inquiry card.

AN-DIG-CONVERTER

New fully transistorized Analog-to-Digital Converter, with speed of 6000 independent conversions per second,

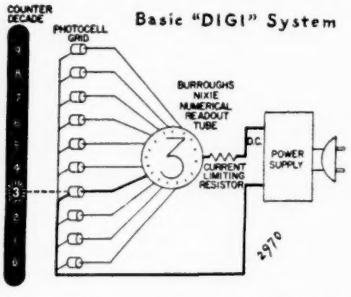


operates at 100,000 bits per second; features accuracy of 0.05% of full-scale (±½ digit). Acceptance of bipolar inputs from −5 to +5 vdc with automatic indication of polarity is optional. Output is in 1-2-2-4 binary decimal code; any other conventional code can be supplied. Both serial and parallel outputs are available.—*Fischer & Porter Co.*, 641 *Jacksonville Road, Hatboro, Penna.*

For more information circle **214** on inquiry card.

DIGITAL TO DIGITAL CONVERTER

New Model 1575 Digidec modernizes an existing decade counting unit by displaying numerals large enough

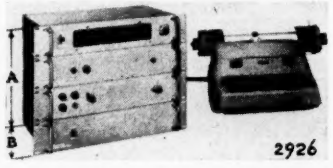


for rapid unambiguous reading in well-lighted rooms; uses no relays, vacuum tubes, thyratrons, transistors or moving parts; is available with either integral Nixie or remote Nixie.—*Radio Frequency Laboratories, Inc., Powerville Rd., Boonton, N. J.*

For more information circle **215** on inquiry card.

DATA HANDLING SYSTEM

New DVA-512 automatically measures alternating or direct voltage and types the result; comprises DVA-512

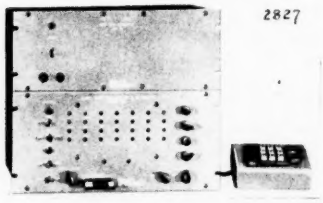


modular ac/dc digital voltmeter (A) plus typewriter control module (B); has 0.0001 to 999.99 volt range, automatic ranging and polarity, stability better 0.01%.—*Electro Instruments, Inc.*, 3540 *Aero Court, San Diego* 11, *Calif.*

For more information circle **216** on inquiry card.

DIGITAL TO DC VOLTAGE CONVERTER

New Model 275 Card Tape Converter and Key Board converts coded-decimal and straight-decimal inputs



to a proportional dc voltage. Five slave relays make controlled circuits compatible with existing accessory equipment. Through its electronic symbol-generation feature, Model 275 can command a recorder pen to describe the following notations:

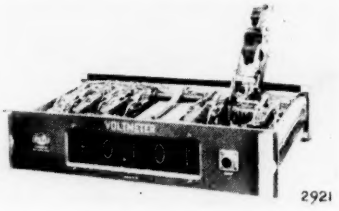
⊢ ⌝ · + ⊣

each of which can be chosen manually or automatically from cards.—*Electro Instruments, Inc.*, 3794 *Rosecrans St., San Diego, Calif.*

For more information circle **217** on inquiry card.

DIGITAL SYSTEMS

New all-transistorized digital systems include digital voltmeter, control unit, ratiometer, ohmeter, ac con-

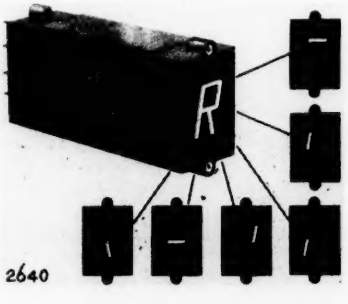


verter, master scanner and printer units. Voltmeter displays polarity symbols, decimal point and AC. Bridge linearity better than 0.01%; resistance 50,000 ohms. Design features: stepping switches mounted on horizontal bars which swing up and out for easy access.—*Cubic Corp., San Diego, Calif.*

For more information circle **218** on inquiry card.

IN-LINE DISPLAY

New Alpha-Numeric Display Unit can display any letter, any number, and + or − symbols; utilizes a 12-



You save in many ways with TEL-O-SET transmitters

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Long life inherent in rugged force-balance mechanism.
All working parts and adjustments protected by weatherproof cover.

Get complete details on *Tel-O-Set* transmitters, receivers, and controllers from your nearby Honeywell field engineer. Call him today . . . he's as near as your phone. MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

Honeywell

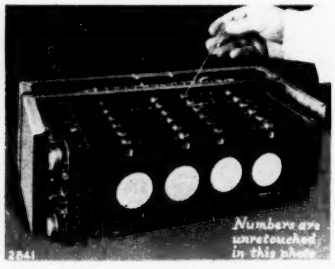
First in Controls

bar matrix, each bar having a miniature projection lamp behind it. Viewing screen is $1\frac{1}{16}$" high and $1\frac{3}{16}$" wide.—*Industrial Electronic Engineers, 3973 Lankershim Blvd., N. Hollywood, Calif.*

For more information circle **219** on inquiry card.

DIGITAL DISPLAY DEVICE

New Model DR-4C all-electronic digital display unit providing easily-read and reliable digital readout for

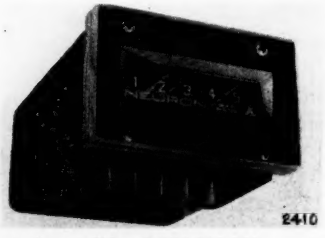


instruments and computers features printed circuit modular construction; is compatible with other decimal and binary components. Reliability is assured by use of passive components in number-generating circuits: no active elements such as vacuum tubes or transistors; nothing to wear out. Printed circuit modular assembly assures easy maintenance: all components are mounted on plug-in printed circuit panels. Photo shows ease of adjusting pots in control units. Wide-angle viewing is provided by displaying number on faces of 2" cathode-ray tubes with nothing in front of each number.—*Hoffman Electronics Corp., Semiconductor Div., 930 Pitner Ave., Evanston, Ill.*

For more information circle **220** on inquiry card.

READOUT COUNTER

New Neuron high-speed electromechanical switch readout counter features rates to 40 counts per sec-



ond; has a life of 300,000,000 counts; offers switch readout function on each point of its five digital wheels; is available with manual or electrical instantaneous pulse reset and for various ac and dc actuation voltages. Its unique bidirectional stepping mechanism cannot double-index during shock, vibration or over-voltage.—*Autron Engineering, Inc., 1254 W. Sixth St., Los Angeles 17, Calif.*

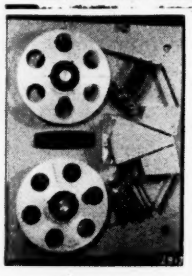
For more information circle **221** on inquiry card.

DIGITAL COMPARISON BRIDGE

New version of maker's Deviation Bridge is available with digital readout; can be used as a computer input with all punched-tape or punched-card data-logging systems. Readings are normally in deviation from nominal value. Range 10 ohms to 20 megohms for resistance models, and 1000 uuf to 10 uf for capacitance models.—*Barnes Development Co., 213 W. Baltimore Ave., Lansdowne, Pa.*

For more information circle **222** on inquiry card.

DIGITAL MAGNETIC-TAPE RECORDER-REPRODUCERS

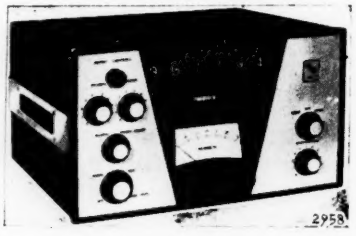


New DataTape 5-680 Series provide standard speeds from $7\frac{1}{2}$ to 100 ips. Two low speeds (0.4 and 0.8 ips) and a high speed (150 ips) also available. Tape widths $\frac{1}{4}$", $\frac{1}{2}$", $\frac{3}{4}$" and 1". Start and stop times <3 ms with guaranteed accuracy of 0.05" forward or reverse. Inputs accepted from an-dig converters, storage registers, punched paper tapes, punched cards and tape readers. Digital mag tape readouts can feed digital computers, card punches, plotters, machine-tool controllers, data printers, etc. Service life >5,000 hr without major overhaul.—*Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.*

For more information circle **223** on inquiry card.

DECADE SCALER

New Model T-1700 features preset stops at every multiple of 10 through 1,000, and 10, 100 and 1000 times each

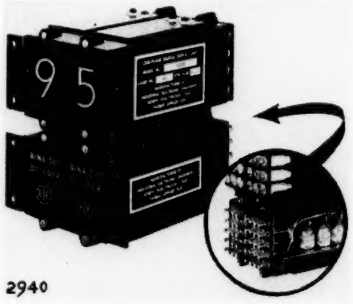


of these numbers. Rotary switch provides stop-count and quick reset. Resettable 8-digit register shows elapsed time in seconds and tenths. Instrument's input sensitivity is 1 mv (200 mv for GM probes with jack). Overall resolution time <1 usec, whence maximal counting rate >500,000 evenly-spaced pps. Feedback-type linear amplifier has >1,000 gain, stability independent of transistor, component and temperature variations.—*Nuclear Corp. of America, NRD Instrument Div., 9842 Manchester Rd., St. Louis 19, Mo.*

For more information circle **224** on inquiry card.

BINARY-TO-DECIMAL DECODER

New Bina-Dec Decoder translates coded information into decimal form, using a relay tree with actual num-



ber of relays depending upon code used. Four or five terminals plus a common terminal for input information to control relays, and ten terminals plus a common for outgoing decimal information. Lockup contacts are available to maintain settings if required for pulse operation.—*Industrial Electronic Engineers, 3973 Lankershim Blvd., North Hollywood, Calif.*

For more information circle **225** on inquiry card.

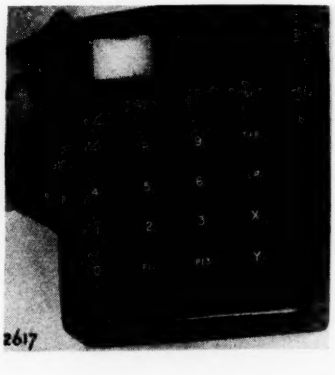
TAPE PRINTER

New 5-digit printing counter makes up to 500 counts per minute and prints total instantly; automatically resets to zero after each impression, or gives cumulative totals. Optional features include additional counters for simultaneous printing on same tape; equipment for printing date and time to nearest minute; printing remotely-selected code letters and numbers.—*Royson Engineering, Hatboro, Pa.*

For more information circle **226** on inquiry card.

JOB-DESIGNED KEYBOARDS

New M-17 keyboards are available with any number of keys, from hand-size to desk-type, with number of dig-



This Tube is Precision Bored to Rifle Barrel Accuracy

Ashcroft Duragauge in Phenol case — a tough, rigid plastic turret type case for wall or flush mounting.

The Bourdon tube in Ashcroft Duragauges is machined mirror-smooth inside and finish ground outside to exact tolerances. Strong, uniformly thick walls assure precise flexibility—sustained high accuracy and long life.

Eight tube materials permit you to select the best metal with sensitivity balanced by internal corrosion resistance. Whether your choice is phosphor bronze, an alloy steel, "K" Monel, a stainless steel or beryllium copper, metallurgical control is exact from ingot to finished tube. Socket and tip joints are welded or brazed, then stress relieved for highest strength and safety. "Whip testing" at pulsating pressures at least 50% greater than rated pressure insures calibration stability.

Order your Ashcroft Duragauges with the best Bourdon tube material for your service. Choose the all-stainless-steel movement or stainless steel with nylon bearings and pinion gear. Full range of pressures, dial sizes, case designs and materials available. In any combination of components, Duragauges give sustained high accuracy and long service. Get details from your industrial supply distributor.

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G2-58

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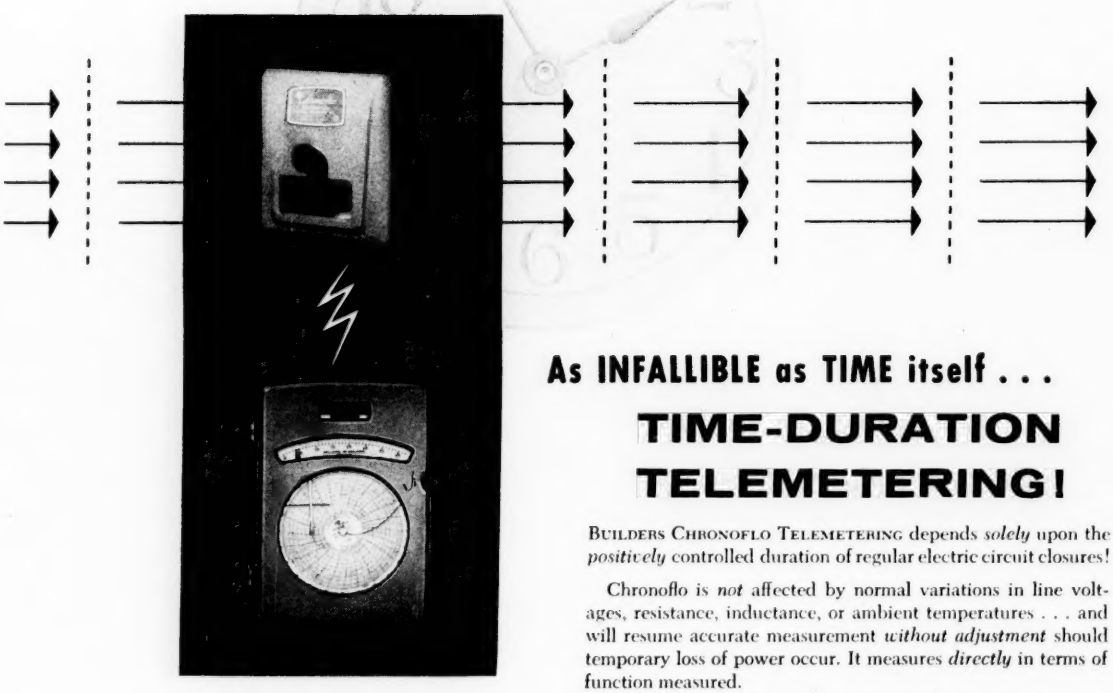
For more information circle **60** on inquiry card.

POSITIVE CONTROL OF MATERIALS IN MOTION B·I·F METERS FEEDERS CONTROLS



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TIME-DURATION TELEMETERING!

BUILDERS CHRONOFLO TELEMETERING depends *solely* upon the *positively* controlled duration of regular electric circuit closures!

Chronoflo is *not* affected by normal variations in line voltages, resistance, inductance, or ambient temperatures . . . and will resume accurate measurement *without adjustment* should temporary loss of power occur. It measures *directly* in terms of function measured.

Chronoflo, used in supervisory control systems, integrates readily into data reduction, tone and/or micro-wave transmission, and similar systems dependent upon electrical transmission media. It brings these systems the many advantages time-duration telemetering has over impulse signal types. With Chronoflo, any of the following functions can be performed more *accurately*, more *dependably*, and more *economically*:

- **REMOTE METERING**
- **IN-PLANT CENTRALIZATION**
- **REMOTE CONTROL**
- **MULTI-FUNCTION METERING**
- **AUTOMATIC CONTROL of time-duration actuated equipment.**

ASK FOR PROOF!

Builders-Providence pioneered time-duration telemetering over 25 years ago . . . and now offers you the experience gained in engineering thousands of performance-proved installations. Prove how this system can make your installation more *accurate*, more *dependable*, and more *economical!* Request Bulletin 230-H4A. Write **Builders-Providence, Inc., 422 Harris Ave., Providence 1, Rhode Island.**

NEW LITERATURE

Please send me the POSITIVE FLOW CONTROL bulletins checked below:

- ☐ Shuntflo Bulletin (400-J10A) . . . for metering air, gas, steam
- ☐ Propeloflo Bulletin (380-K4B) . . . for metering water
- ☐ Conveyoflo Bulletin (550-P5) . . . for weighing belt-conveyed materials
- ☐ Chronoflo Bulletin (230-H4B) . . . for telemetering and control
- ☐ Venturi Flow Nozzle Bulletin 130-E2A . . . for high pressure, high temperature metering
- ☐ Dall Flow Tube (DFT-PI) Bulletin 115-R1 . . . for low cost, specialized metering

Name .....

Company .....

Address .....

City ..... *State* .....

BUILDERS-PROVIDENCE
DIVISION OF
B-I-F INDUSTRIES B·I·F METERS FEEDERS CONTROLS

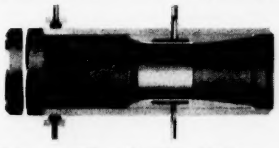
For more information circle **69** on inquiry card.

SPECIFY B·I·F

FLOW METERING ELEMENTS FOR CORROSIVE FLUIDS

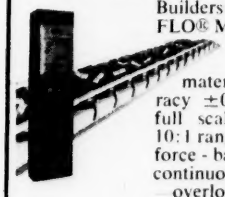
Builders Model DFT-PI Dall Flow Tube . . . insert-type, plastic primary metering element. Low cost, accurate. Suitable for most applications, especially corrosive fluids. Bulletin 115-R1.

FOR HIGH PRESSURES & TEMPERATURES



Builders X-TRA-HI Flow Meters . . . for high temperature, high pressure applications . . . proven in primary loop of every major atomic reactor in America. Bulletin 130-E2A.

DRY MATERIALS METERING

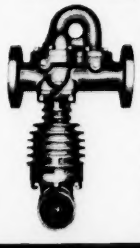


Builders CONVEYO-FLO® Meter . . . totalizes belt-conveyed materials — accuracy ±0.5 of 1% of full scale load over 10:1 range. Pneumatic force-balance system continuous integration — overload protection — explosion-proof. Bulletin 550-P5.

LIQUID METERING

Builders PROPELOFLO® Meter . . . direct-reading, propeller-type liquid meter . . . 2" to 20" lines . . . within ±2% of actual flow over specified range . . . capacities ranging from 15 to 5,800 GPM. Bulletin 380-K4B.

STEAM, AIR, GAS METERING



Builders Shuntflo Meter . . . self-contained, self-operated meter . . . for 1" to 24" line sizes . . . accurate within ±2% of actual rate of flow. Provides continuous and automatic pressure compensation. Bulletin 400-J10A.

MAIL COUPON TODAY!

For more information circle **69** on inquiry card.

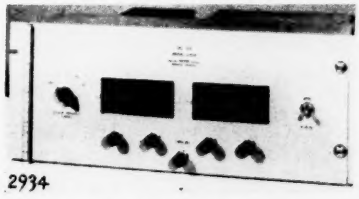
NEW INSTRUMENTS

its and letters to customer's specs. Should operating conditions change, keys can readily be re-arranged, replaced, or disconnected. Each key can operate two n-o and two n-c contacts simultaneously. Keyboards can be used in ac or dc circuits of 6 to 120 v; keys actuate snap-action switches typically rated at 1 amp and 120 v with life of over 20 million cycles.—*Concord Controls, Inc., Boston, Mass.*

For more information circle **227** on inquiry card.

DIGITAL CLOCKS

New Type DC-100 Digital Clocks are specifically designed for continuous operation in industrial applica-

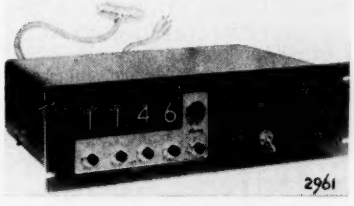


tions. Standard DC-104 clock provides a digital output in the form of contact closures representing hours and minutes; visual readout; individual Time Set push buttons below each window; rotary switch for selecting automatic readout-initiate pulse at desired intervals; and interlock contacts whereby clock position can be locked during printout without loss of timing accuracy.—*G. M. Giannini & Co., Datex Div., 1307 So. Myrtle Ave., Monrovia, Calif.*

For more information circle **228** on inquiry card.

DIGITAL LOGGING CLOCK

New digital clock, for use in digital data logging systems and control applications, features single-plane in-

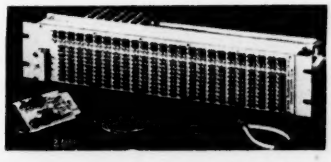


line lamp bank assembly which can be remotely installed in suitable custom consoles to save front panel space. Removable assembly includes individual time reset push-buttons for each decade for setting a desired value in a particular column without interaction between columns. Choice of several standard models in 24-hr and 12-hr AM-PM configurations, with one or two sets of contacts wired to a quick-disconnect plug for remote operation of electric typewriters, printers, punches, etc.—*Parabam, Inc., 110 Lomita St., El Segundo, Calif.*

For more information circle **229** on inquiry card.

DIGITAL SYSTEM PLUGBOARD

New Model B101 M-PAC enables designer to test or verify new system ideas in shortest time and at least ex-

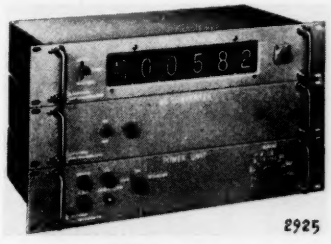


pense. It provides standard 12-pin printed circuit connectors with guide pins for 24 transistorized Series M 3C-PACs. Any Series M package can be mounted in any connector. All twelve terminals per connector are wired to corresponding vertical column of paired jacks on front panel to provide complete usage flexibility. —*Computer Control Co., Inc., 92 Broad St., Wellesley, Mass.*

For more information circle **230** on inquiry card.

AC/DC DIGITAL VOLTMETER

New Model DVA-510 for measuring alternating or direct voltages comprises transistorized Power Module,



dc Switch Module and ac Converter Module; has a range of 0.0001 to 999.99 volts, automatic ranging and polarity, 0.01% stability.—*Electro Instruments, Inc., 3540 Aero Court, San Diego 11, Calif.*

For more information circle **231** on inquiry card.

DIGITAL VOLTMETER

New all-electronic Model 801 measures from 0.001 to 1000 vdc with 0.1% accuracy; employs a successive-ap-

proximation (trial-voltage comparison) circuit—a direct digital technique said to offer greater speed, reliability, accuracy and stability than voltage-ramp or time-measuring methods; takes less than 0.1 sec to

display measured voltage. Polarity and ranging are manual. Total time required for complete 3-digit conversion is 0.07 sec. Display time is adjustable from 0.1 sec to infinity ("read once" pushbutton gives a new reading when display time is set at infinity).—*Kin Tel, Div. Cohu Electronics, Inc., 5725 Kearny Villa Rd., Box 623, San Diego 12, Calif.*

For more information circle **232** on inquiry card.

DIGITAL VOLT-OHMETER

New all-electronic Model 400A, insensitive to tube selection, features a unique new electronic decade counter

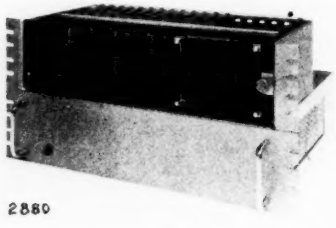
2834

design never before used in VTVM instruments, said to provide "greater, more lasting reliability." It measures positive or negative direct voltages from 0.01 to 1000, alternating voltages to 1000 (to 100 kc with standard probe; provision for accessory HF probe) and resistances from 10 ohms to 10 megohms.—*Dept. 514, Franklin Electronics, Inc., Bridgeport, Pa.*

For more information circle **233** on inquiry card.

PUNCHED CARD BUFFER

New Type 80-CB-7 converts data from punched cards to a form which can be utilized by serial devices;



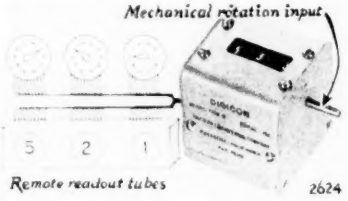
2880

stores up to 80 alpha-numeric characters (full contents of a standard card); features reliability as a result of solid-state design: use of transistors, diodes, and ferrite-core active elements.—*Telemeter Magnetics, Inc., 2245 Pontius Ave., Los Angeles 64, Calif.*

For more information circle **234** on inquiry card.

LOW-TORQUE COUNTER

New Model 7102 Digicon mechanical counter with electrical readout combines low torque (0.5 oz-in) with



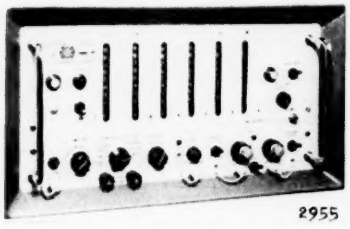
2624

high operational speed (2,000 rpm); is small (1.7" x 1.9" x 1.9") and ruggedized for temperatures from −40° C to 85° C and accelerations up to 10 G.—*Digitran Co., 45 W. Union St., Pasadena, Calif.*

For more information circle **235** on inquiry card.

TIME AND FREQUENCY COUNTER

New Model 13-20 Counter measures frequencies from 10 cps to 1.1 Mc, period from 0 to 10 kc, time interval



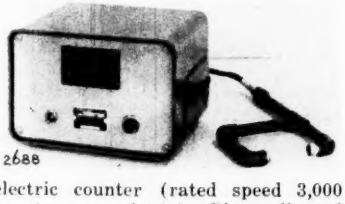
2955

from 3 usec to 100,000 sec, total events from 1 to 999,999. It can be used as a secondary frequency standard with outputs at 10 cps, 1 kc, 100 kc and 1 Mc. Automatic decimal point, and simplicity of controls, suit it for use by non-technical personnel. Output frequency division pulses can be supplied at marker pulse output connector; division constants of 10 to 100,000 in steps of ten are useful as markers or for triggering auxiliary equipment. Printer and 'scope connectors available at rear of panel.—*Northeastern Engineering, Inc., 25 S. Bedford St., Manchester, N. H.*

For more information circle **236** on inquiry card.

PHOTOELECTRIC COUNTERS

New Model C Count-Pak, first of a new series of counting packages, features maker's instant-reset long-life



2688

electric counter (rated speed 3,000 counts per minute). Photocell and light source are permanently assembled so that vibration will not jar them out of focus. Pulses as short as 0.0002 sec will actuate device. Interruptions or variations of a direct or reflected light beam can be utilized. ★ New Model N-1 Count-Pak utilizes a compact glow-transfer cold-cathode counting tube, a high-speed magnetic counter, and a permanently-assembled light-source and photocell; is designed to count accurately at speeds up to 30,000 counts per minute for more than one billion counts.—*Veeder-Root Inc., Electronic Controls Div., Hartford 2, Conn.*

For more information circle **237** on inquiry card.

QUICK-RESET COUNTER

New Series 1522 is available either with or without predetermining wheels; instantly resets to zero by

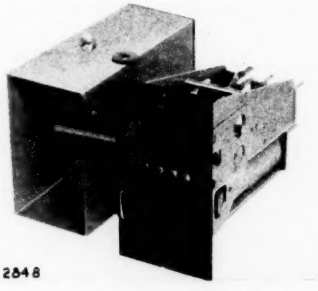
2982

depressing reset level through 60° arc. Also, if desired, counter will subtract in opposite direction. Speeds up to 6000 rpm of drive shaft and 8000 counts per minute are maximum recommended.—*Veeder-Root Inc., Hartford 2, Conn.*

For more information circle **238** on inquiry card.

PRESET IMPULSE COUNTER

New preselection Type TCeZ4PE features speeds up to 25 impulses per second, service life 50 million im-



2848

pulses for counter and 500,000 for resetting system (which can be operated manually or electrically). Figure drums can be set to any number to 9999; each incoming impulse subtracts one until, at zero, double-throw switch is operated, of which n-c legs can be used to interrupt flow of impulses while n-o legs can be used to repeat counting cycle automatically. At end of a counting run, counter can also be reset to originally preset figure by means of a push button.—*Landis & Gyr, Inc., 45 W. 45th St., New York 36, N. Y.*

For more information circle **239** on inquiry card.

Here is Why!

You can dispense with oil filters and dust filters when you install ®Nash® Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

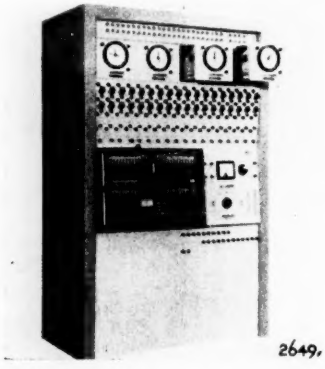
No oil filters.
No dust filters.
No internal lubrication to contaminate air handled.
No internal wearing parts.
No valves, pistons, or vanes.
Non-pulsating pressure.
Original performance constant over a long pump life.
Low maintenance cost.

NASH ENGINEERING COMPANY
370 WILSON, SO. NORWALK, CONN.

computing and data processing

ANALOG COMPUTER

New Model MC-5800 high-precision analog computer employs unique expanded circuit logic so that it can be



expanded in the field on a building-block basis without rewiring or mechanical modification: when purchasing, it is unnecessary to decide irrevocably whether or not digital input-output system, dynamic problem check, repetitive operations mode, etc., are essential features, as these functions can be added later. Entirely new packaging technique: computer can be instantly "unzippered" from its cabinet for unobstructed access during maintenance.—*Mid-Century Instrumatic Corp.*, 611 *Broadway, New York, N. Y.*

For more information circle **240** on inquiry card.

OSCILLOGRAM TRACE READER AND COMPUTER

New semi-automatic multiple-trace-reading Model 12 OTRAC has controls to permit direct reading, in tab-

ulated form, of the digital parameters to which traces correspond. Up to ten or more traces can be read sequentially by manually positioning a cross-hair on *X* and *Y* axes: cross-hair position controls two proportional analog voltages which are automatically corrected for scale factor and zero corrections; result is fed to digital voltmeter, whose reading is recorded by an automatic typewriter and simultaneously punched out on paper tape or cards.—*Non-Linear Systems, Inc., Del Mar, Calif.*

For more information circle **241** on inquiry card.

DATA PROCESSING SYSTEM

New Model 123 System retains Model 112's reliability and accuracy; can scan 100 points at rate of one per second; provides 25 combinations of scaling and zero offset, high or low alarm limits, and square-root extraction for flow-rate computation; utilizes the same components as Model 112: transistors throughout, sealed stepping switches, and all solid state components. Programming is simplified by use of Beckman Systems Pinboard. Cost has been minimized by manufacturing Model 123 as a standard item rather than customizing each individual system.—*Beckman/Systems Div., 325 N. Muller Ave., Anaheim, Calif.*

For more information circle **242** on inquiry card.

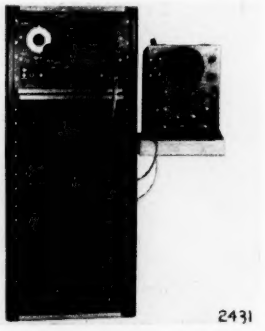
AUTOMATIC WAVE ANALYZER

New special-purpose analog computer provides permanent record of frequency analysis from 3 to 10,000 cps plotted as either amplitude *vs.* frequency (Fourier), power *vs.* frequency, or amplitude of a specific frequency *vs.* time. Cross-spectral or transfer-function data are provided when two channels are used. Frequency accuracy <1 cps from 3 to 50 cps and 2% from 50 to 10,000 cps. Automatic switching input panels (optional) permit handling and analyzing up to 14 channels of data sequentially.—*Davies Laboratories Div., Minneapolis-Honeywell*, 10721 *Hanna St., Beltsville, Md.*

For more information circle **243** on inquiry card.

RESPONSE ANALYZER

New Transient Response Analyzer for solving complex problems in behavior of mechanical systems utilizes



response spectrum method of analysis which expresses maximal value of a selected response parameter directly in terms of a continuum of assumed values of natural frequencies and/or damping system. Electric analog often saves time and effort in response analysis by obviating need for graphical or numerical solutions.—*Dynamic Measurements Corp., 40 S. Los Robles Ave., Pasadena, Calif.*

For more information circle **244** on inquiry card.

MINIATURIZED ELECTRONICS FOR AIRBORNE TAPE DEVICES

Four new record amplifiers and a new power supply, for in-flight testing with magnetic tape instrumentation, feature printed wiring, transistors, and modular construction; operate at temperatures up to 100°C. Housed in aluminum die-cast cases, new units are said to be the smallest (6¼x3¼x1¼") and lightest (10 to 12 oz) record amplifiers on the market today. New interchangeable modules are designed to provide analog, analog with voice, PDM or FM recording on tape. All units are part of CEC's Airborne DataTape Magnetic Tape System. Any combination of these modules can be neatly and rigidly housed in a special amplifier case

ALL-TRANSISTOR DATA-PROCESSING SYSTEM

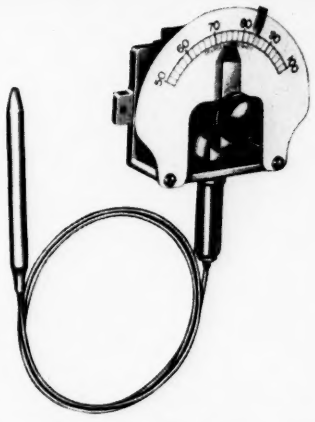
New all-transistor Transac S-2000, said to be "the world's fastest and most reliable electronic problem

solver," features "speeds from three to ten times faster than conventional vacuum-tube systems"; takes up an area one-tenth of that for vacuum-tube computers; does not require special air conditioning equipment and, though it consumes as much current as an ordinary electric cook stove, "can read and memorize data equivalent to the contents of the entire Bible in less than one minute!"—*Philco Corp., Gov't and Industrial Div., Philadelphia 44, Pa.*

For more information circle **245** on inquiry card.

NEW INDICATING TEMPERATURE CONTROL

Range Limits —100 to +600°F E65N



New Design gives maximum accuracy at low cost!

The UE Type E65N control is offered in basic skeleton form so that it may be easily incorporated, or designed into equipment, without the need and expense of an enclosure. Enclosures, however, are available upon specification. Setting and indication are clearly visible on a single scale allowing easy reference between the setting and controlling temperatures. Ideal for incubators, centrifuges, oxygen tents, sterilizers, and other applications where it is necessary to control and indicate temperature of gases, liquids and hot plates.

Temperature Ranges	A wide variety of scales between −100 & +600°F.
Thermal Assemblies	Standard 4' capillary with several bulb styles and sizes.
Operation	Liquid filled bellows assembly expands or contracts with heating or cooling thus actuating a snap-acting electrical switch at desired control point.
Switch Ratings	15 amps 115/230 volts AC. DC and other special switches available.
Switch Actions	Normally closed; normally open; and double throw, no neutral position.
Electrical Connections	Lead wires attached to terminal on switch.
Size & Weight	1 lb; scale plate 4½" wide.
Variations	Design variations available on request.

UNITED ELECTRIC *manufactures a complete line of temperature, pressure and vacuum controls. For application requiring custom-built units or modified standard units, call upon a UE application engineer for recommendations. Request Type E65N Design Catalog Sheet for complete specification and pricing data and for information regarding other United Electric temperature controls.*

United Electric Controls
COMPANY
85 SCHOOL STREET, WATERTOWN, MASS

For more information circle **70** on inquiry card.

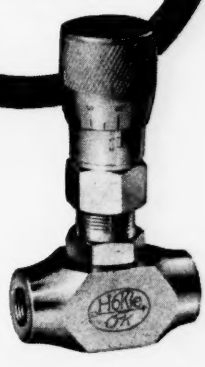
INSTRUMENT ENGINEERS . . .

control small flows

with finger tip accuracy

on

Aircraft and Automotive Test Stands
Hydraulic Equipment
Pneumatic Equipment
Gas Analyzers
Metering and Proportioning Equipment
Pilot Plants
Test Instruments



280 SERIES METERING VALVES

Two orifice sizes of 1/16" and 1/8" are available with flow controlled by an 8-degree needle point taking 20 turns to move from open to closed position. In brass with O-ring stem seal or in 316 stainless with Teflon packing. For service to 3,000 psi, operating temperatures from −60° to 450°F. All valves have panel mounting lock nut.

Vernier Modifications

Hoke's #280-25 micrometer hand wheel kit (illustrated) helps you establish a reference point as to the number of turns required for any flow rate. A low-cost, high-value accessory for precision control.

A SPECK OF DUST

in metered fluid is all it takes to change the orifice setting in Hoke's highly-sensitive 280 Series valve. For critical metering requirements, it's always wise to use this 540 Series Micron Filter to keep foreign matter away from the valve. Complete information on request.

Why buy big when you can buy small

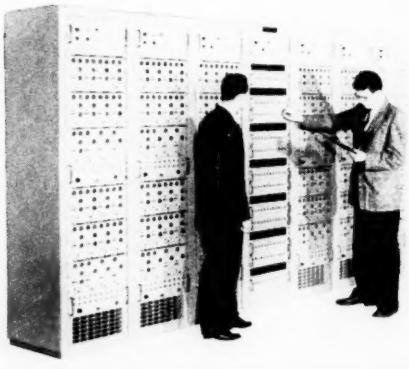
Hoke's Catalog MV-957 has all necessary information on 280 Series Valves and 540 Series Micron Filters. Yours for the asking.

OK

HOKE INCORPORATED
FLUID CONTROL SPECIALISTS
231 South Dean Street
Englewood, New Jersey

For more information circle **71** on inquiry card.

High-Accuracy FM Systems*



*0.15% system accuracy

Wiancko's packaged FM systems will obtain and store massive amounts of dynamic test data with unmatched precision. This accuracy means less data scatter—better information from each test.

Wiancko systems are economical and easy to operate. Multiplexing, or "packing," various IRIG bands on a single tape track permits the recording of over 144 channels of information on one tape recording head. Packing results in more data with less equipment and a permanent, versatile recording that can be processed by automatic data reduction equipment and be converted to analog form for graphic display. Automatic calibration, zero suppression, adjustable FM oscillators, and "normally thru" input patching provide convenience of operation. Inputs acceptable by Wiancko FM systems include variable voltage, strain gage, variable reluctance, and variable resistance.

Adaptable to a great many applications and requirements, Wiancko FM systems are a ready-made answer to ground-based telemetering problems. Systems can be packaged, using the Wiancko "building block module" principle, to meet practically any specification.

For more detailed information, write for Product Bulletin 104

WIANCKO ENGINEERING COMPANY
255 North Halstead Avenue, Pasadena, California

Field Offices:

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- **Northern California** — Cowper-Hamilton Bldg., Palo Alto, California, Phone: DAvenport 6-7053
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For more information circle **72** on inquiry card.

ONE HUNDRED ELECTRONIC CIRCUITS

Volume I (Circuits 1-100)

Milton H. Aronson **Charles F. Kezer**

COVERS

Power Supply Circuits	Test Instrument Circuits
Amplifier Circuits	Phase Shifters
Oscillator Circuits	Alarms
Pulse Circuits	Controllers

$2.00 postpaid

INSTRUMENTS PUBLISHING CO.
845 Ridge Ave., Pittsburgh 12, Pa.

NEW INSTRUMENTS

which likewise is a die-cast module. Shockmounts are not required for new units, whether stacked or separate. Blower units supply cooling air to Power Supply and each Record Amplifier case.—*Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.*

For more information circle **246** on inquiry card.

TAPE TRANSPORT

New precision tape transport for telemetering and other analog data applications exceeds IRIG requirements; permits recording data separately or in combination by direct-recording FM or PWM; can handle up to 14" reels as standard, tape widths ¼" to 2" changeable in the field. Six tape speeds from 1⅞ to 60 ips instantaneously selectable.—*Davies Labs Div., Minneapolis-Honeywell, 10721 Hanna St., Beltsville, Md.*

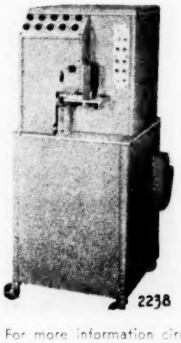
For more information circle **247** on inquiry card.

TAPE AND PAPER SPLICER

New electric automatic splicer for digital tapes, paper, magnetic tapes and films utilizes design based upon proper combination of controlled heat, pressure, and automatic time cycle; does not require cement or adhesive. Fusing is accomplished within 2¾ seconds.—*Prestoseal Mfg. Corp., 37-27 33rd St., Long Island City, N. Y.*

For more information circle **248** on inquiry card.

TAG-TO-CARD CONVERTER



New Kimball Tag Reader, adjunct to Model 75 Punch Marking Machine, when connected to an IBM Summary Punch, senses and converts information from Kimball Punched Tags to IBM cards. Rate 100 per minute.—*A. Kimball Co., 444 4th Ave., New York 16, N. Y.*

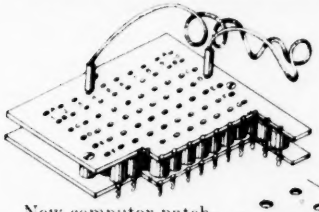
For more information circle **249** on inquiry card.

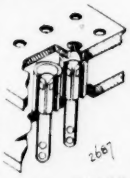
DATA TRANSLATORS

New Data Translators feature building-block concept (custom installations to suit individual needs constructed from standard modules); provide compatibility between computers of different designs via almost any conceivable combination of punched cards, paper tape, or magnetic tape. Reliability and accuracy are said to be high owing to use of solid-state components and internal automatic checking codes. Functions peculiar to various processing are performed simultaneously: tape bad-spot detection, parity check, block check, end-of-file, and end-of-tape. Size: 54" h 42" w x 30" d.—*Telemeter Magnetics, Inc.*, 2245 *Pontius Ave., Los Angeles* 64, *Calif.*

For more information circle **250** on inquiry card.

COMPUTER PATCHBOARDS



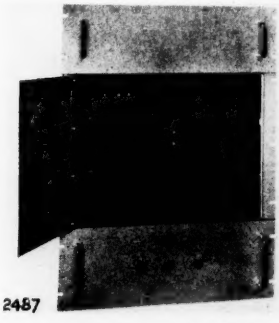


New computer patchboards, for multi-connection single-conductor patching, are particularly useful for test panels and low-cost computers. Standard blocks: 100 receptacles on 0.265" centers, ten rows of ten receptacles each.—*Vector Electronic Co.*, 1100 *Flower St., Glendale* 1, *Calif.*

For more information circle **251** on inquiry card.

MAGNETIC CORE BUFFER

New Type 120-CB-56 Coincident-Current Core Storage Unit for application to high-speed line printer sys-



tems accepts sequential character inputs at rates up to 50 kc and will store a "print-wheel image." Its 120 columns of up to 64 characters can then be read at rates up to 50,000 character positions per second.—*Telemeter Magnetics, Inc.*, 2245 *Pontius Ave., Los Angeles* 64, *Calif.*

For more information circle **252** on inquiry card.

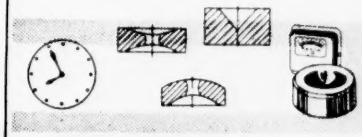
PRECISION

defined by the dictionary

. . . . "the quality or state of being precise; accuracy; mechanical exactness."

defined by an instrument maker . . .

Swiss American



JEWEL BEARINGS

Sapphire and Ruby Precision Jewel Bearings

FEATURE
- exact tolerances
- high shock resistance
- low friction coefficient

FOR
- INSTRUMENTS
- CLOCKS
- METERS
- MEASURING DEVICES

Individually Set To Order. Mass Produced For Industrial Requirements.

For detailed information, send specifications or contact

SWISS AMERICAN JEWEL BEARINGS CO.
32-30 58th St., Woodside 2, Long Island, N. Y.
ONE OF THE LARGEST FACTORIES OF ITS KIND IN THE WORLD

For more information circle **73** on inquiry card.

Model F

OPTA-VUE MICRO-READER

Not a "scanner"... not a "micromagnifier!" The one and only instrument engineered exclusively for "picture-window" viewing and reading of *all-types* of microfilm material . . . *with both eyes open!*

COMPARE THESE FEATURES:
- Accepts material up to 70mm.
- Ground and polished Triple-Lens optical system.
- Adjustable lock-ring focusing.
- Wide aperture objective for on-axis and off-axis viewing.
- Highly polished pressure back—opens quickly, grips firmly . . . without scratching.

CHOICE OF OBJECTIVES
8-power, for reduction rate 16x-22x, field appr. 1" sq.
12-power, for reduction rate 22x-30x, field appr. 5/8" sq.

29.50

Accessory 110V. AC Illuminator Available

INDUSTRIAL DIVISION
OPTICS MANUFACTURING CORPORATION
Amber & Willard Streets • Phila. 34, Pa.

For more information circle **74** on inquiry card.

NORTHAM

HIGH SENSITIVITY, LOW RANGE
PRESSURE TRANSDUCER

Diameter: 2¼"

Weight: 12 oz.

An extremely sensitive variable inductance instrument for measurement of steady and transient pressure in full scale ranges as low as ± 4 inches of water. Permissible pressure overload in either direction up to maximum line pressure, 100 psi, for difficult flow-metering applications. A light diaphragm sensing element free from external mechanical linkage results in high natural frequency for dynamic measurements.

MODEL DP-7 SPECIFICATIONS:

Pressure Ranges:....± 0.15 to ± 15 psid
Maximum Line Pressure:.....100 psi
Accuracy:.....± 1% full scale
Excitation Frequency: From 60 to 20,000 cps
Natural Frequency: From 250 cps for 0.15 psi range to 2500 cps for 15 psi range

WRITE FOR BULLETIN

Northam Engineering Facilities Are Available To Assist You With Any Application Problems.

NORTHAM PRODUCTS INCLUDE . . .

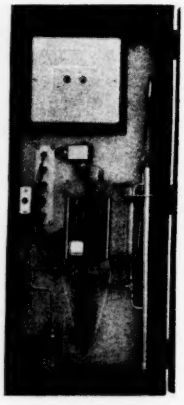
Transducers for pressure, acceleration and displacement measurement and auxiliary electronic equipment for complete systems.

NORTHAM ELECTRONICS, INC.
A Subsidiary of Norris-Thermador Corp.
2420 North Lake Avenue, Altadena, Calif.

For more information circle **75** on inquiry card.

process analyzers, monitors, controllers

DISSOLVED OXYGEN ANALYZER

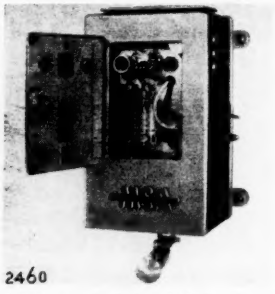


New Model 70 continuously measures dissolved oxygen in high-purity water, detects one part per billion; utilizes a rapid and irreversible chemical reaction specific for dissolved oxygen. Signal output (0-5 mv) can feed recording potentiometer. Calibration and zero stability within 1 ppb for periods of weeks. —*Beckman/Process Instruments Div., Fullerton, Calif.*

For more information circle **253** on inquiry card.

COMBUSTIBLE-GAS ALARM

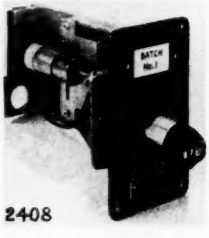
New small self-contained Explosilarm features minimal first cost, negligible installation cost, and low



maintenance; is intended for installation in non-hazardous areas and can use a sample line as long as 100 ft. It utilizes same principle of operation as in larger M-S-A gas alarms and analyzers.—*Mine Safety Appliances Co., Pittsburgh 8, Pa.*

For more information circle **254** on inquiry card.

SET-POINT TRANSMITTER



New Set-Point Transmitter employs a displacement pickup (LDTT) as position-sensing element; provides Atcotran System with a device suitable for remotely adjusting a control relay's set-point. Digital readout dial provides precise set-point adjustment.—*Automatic Timing & Controls, Inc., King of Prussia, Pa.*

For more information circle **255** on inquiry card.

REMOTE CONTROL

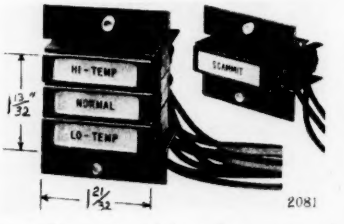
New Metertrol, when used with maker's Shaftrol shaft-mounted gearmotor, provides remote or automatic

control for valves, variable-speed drives, etc.; also provides indication by a 0-100 milliammeter with a linear response to valve or drive setting: full accuracy all the way to zero. *Jordan Co., Inc., 3235 W. Hampton Ave., Milwaukee 9, Wis.*

For more information circle **256** on inquiry card.

MINIATURE ANNUNCIATORS

New miniature Model ST-AM Scammit indicator contains all necessary circuit elements to function as

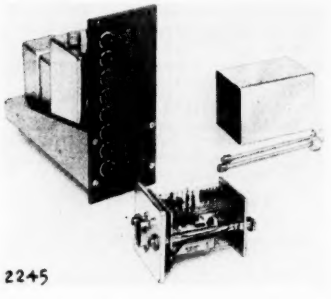


a regular annunciator; has no moving parts. Choice of wire leads (illus.) for field connections, or permanent soldering pins. For constant performance, two bulbs are provided in parallel.—*The Scam Instrument Corp., 1811 W. Irving Park Rd., Chicago 13, Ill.*

For more information circle **257** on inquiry card.

AUTOMATIC ALARM AND SCANNING SYSTEM

New Monitron gathers alarm and control data from remote measuring stations in plants, utilities, pipelines, etc.; transmits these data to a central station over wire or radio for visual

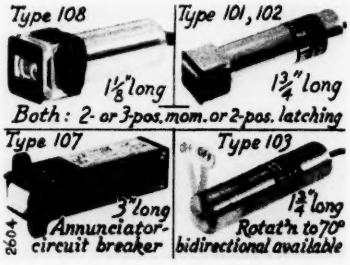


and aural presentation. It uses transistors and diodes; has no moving parts. Scanning rates from 0.00004 sec to 0.2 sec per step.—*Moore Associates, Inc., 2600 Spring St., Redwood City, Calif.*

For more information circle **258** on inquiry card.

SIGNALING DEVICES

New line of electromechanical visual indicators comprises models for panel and instrument mounting which



meet or exceed MIL-E-5272a specs and feature high readability under strong incident light.—*Allard Instrument Corp., 146 E. 2nd St., Mineola, L. I., N. Y.*

For more information circle **259** on inquiry card.

OXYGEN INDICATOR

New Portable Oxygen Indicator has range of 0 to 25% oxygen content by volume; 0.5% accuracy; square-root-law scale with 5% graduation near center; weighs 5¾ lb complete with sampling line; comes with leather waist and neck straps. Sampling lines and probes of different lengths and types, and a line trap assembly, are available.—*Mine Safety Appliances Co., Pittsburgh 8, Pa.*

For more information circle **260** on inquiry card.

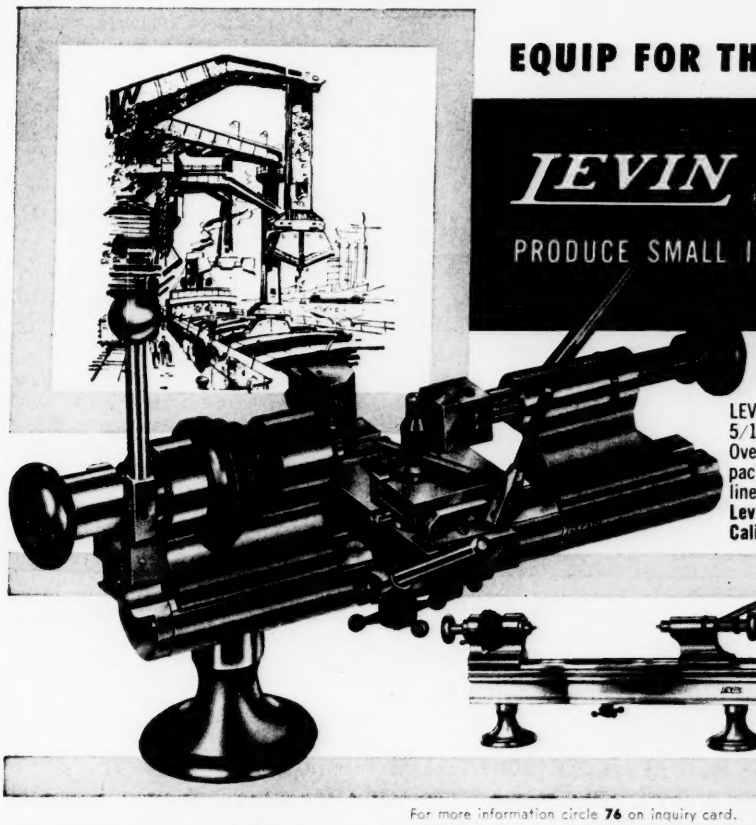
GAS CHROMATOGRAPH

New research Model K-5 of maker's Kromo-Tog greatly extends application of gas and vapor chroma-

EQUIP FOR THE SIZE OF THE JOB

LEVIN® INSTRUMENT LATHES

PRODUCE SMALL INSTRUMENT PARTS BETTER

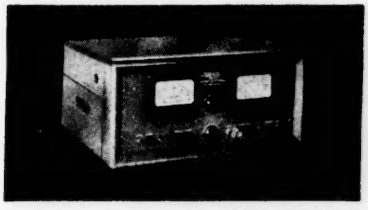


LEVIN lathes are made in two collet capacities, 5/16" or 3/16", and thirty-three different models. Over 150 sizes of collets available in either capacity. Send for catalog "M" describing complete line of instrument lathes and accessories. **Louis Levin & Son, Inc., 3610 S. Broadway, Los Angeles 7, California.**

For efficiency small work should be done on a small lathe. In many cases the work done on an instrument lathe requires a degree of precision and fine finish which cannot be obtained from larger machines.

For more information circle **76** on inquiry card.

neW **ALL-PURPOSE REGULATED D.C. POWER SUPPLY MODEL L3520A, PRECISION REGULATED, 0.1% CONTINUOUSLY VARIABLE, 0-350V, 0-200 Ma**



MODEL L3520AM

Low Output Impedance:	0.2 OHM AC
Transient Response:	1 millisecond
Ripple:	1 millivolt, R.M.S.
Stabilized Bias:	0 to —150V, 0-5 Ma
Filament Source:	6.3 VAC, C.T., 0-10 Amps
Line Input:	105-125 VAC, 50-400 cycles
For Rack Mounting:	Panel, 7" x 19"; Depth, 8"

Model L3520A, less meters, only **$199.50**
Model L3520AM, with meters . . $229.50
As shown, deluxe cabinet . . . $264.50

ORDER FOR IMMEDIATE DELIVERY FROM STOCK

UNIVERSAL ELECTRONICS COMPANY
1720 TWENTY-SECOND STREET, SANTA MONICA, CALIFORNIA
Write for complete bulletin D58-1
REPRESENTATIVES IN PRINCIPAL U. S. CITIES

For more information circle **77** on inquiry card.

MARSHALLTOWN

DIAPHRAGM GAUGE FOR ACCURATE PRESSURE MEASUREMENT IN OUNCES OR INCHES OF WATER

Marshalltown Figure 83 is an extremely sensitive gauge that uses a carefully seasoned bronze diaphragm to accurately measure very low pressures. It is used extensively on many types of natural gas installations for checking low pressures.

Available in standard dials (reading in inches of water) 0-15" -0-30" -0-60" -0-100" -0-160" . . . also in ounce graduated dials from 15 ounces to 5 pounds. 2½", 3½" and 4½" dial sizes mounted in black enameled steel case.

Write for details and price. LOOK TO MARSHALLTOWN FOR ONE OE THE MOST COMPLETE LINES OF INDICATING PRESSURE GAUGES MADE!

MARSHALLTOWN MFG. COMPANY
MARSHALLTOWN 3, IOWA

For more information circle **78** on inquiry card.

37 UP TO CHANNELS IN THE Voice Band (300 to 3000 CPS)

with Comvor®

DATA TRANSMISSION TERMINAL

RFL Model 912
Operates over Wire Circuit or Microwave

•

Reliable HIGH-SPEED Continuous Control of
PUMPS
VALVES
MOTORS
GENERATORS
RELAYS
ETC.

The Model 912 Comvor, an audio frequency shift terminal, is used in the transmission of telemeter, telegraph or control signals over either wire line, microwave, or carrier. Up to 90 individual information channels are available in the audio spectrum.

Reliable frequency shift method of keying is used. All essential controls such as transmitter output level and receiver input level are included.

Each terminal contains its own power supply which provides an additional 60 milliamperes at both the transmitter and receiver for the operation of relays, stepping switches, selector magnets, and other components used in telemetering, control and telegraph applications.

WE CAN HELP YOU
Our Applications Department is ready to assist you in your control, telemetering or communications problem. Phone DEerfield 4-3100.

Write for Technical and Application Data.

Radio Frequency LABORATORIES, INC.
Boonton, New Jersey, U.S.A.

For more information circle **79** on inquiry card.

tography; enables analyzing materials that boil up to 475°C and higher, including fatty acids and other compounds containing as high as 36 carbon atoms and on into unexplored temperature regions. It is available with one or two complete systems; two-system instrument can have either one or two recorders. Sensitivity: 1 ppm (even better under controlled conditions).—*Burrell Corp., 2223 Fifth Ave., Pittsburgh 19, Penna.*

For more information circle **261** on inquiry card.

temperature and humidity

INDUSTRIAL THERMOMETERS

New models of 9" industrial thermometers feature cast brass case that withstands industrial vapors and corrosive sea atmosphere; tube recessed between halves of two-piece scale to eliminate parallax; good thermal contact with walls of separable socket. Many ranges available between limits of −120° F and 1200° F.—*Precision Thermometer & Instrument Co., 1434 Brandywine St., Philadelphia 30, Pa.*

For more information circle **262** on inquiry card.

INDUSTRIAL THERMOMETERS

Newly redesigned Series 140 submarine type industrial thermometer has 5¾" x 1⅜" one-piece brass-forging case finished in smooth gray enamel to USN specs; is said to be unusually efficient in industrial applications where space is an important factor. All standard ranges; brass or Monel sockets in five different rigid angles, or with maker's Adjust-Angle. —*Weksler Instruments Corp., Freeport, L. I., N. Y.*

For more information circle **265** on inquiry card.

H&T RECORDER CONTROLLER

New Model HGS-HYT-1C humidity and temperature recorder-controller comprises a Sensing Section and a

Monitoring Section; provides humidity readings accurate to 3% RH within its operating range of 15% to 95% RH at temperatures from 32° F to 130° F. Temperature readings are accurate to 1 F° over 0° F to 100° F range. Control points for H&T are set by locating electrical contact blocks in relation to H&T pen-arms in Sensing Section.—*Serdex, Inc., 12 Bowdoin Sq., Boston 14, Mass.*

For more information circle **263** on inquiry card.

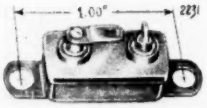
LOW-TEMPERATURE PROBE

New Semiconductor Series 7XXXL provides output of 0.5 vdc for a span of only 20 F° in liquid oxygen (LOX)

temperature range when used with maker's TME system or similar equipment; also for liquid argon and other liquefied gases between −240° F and −320° F. Calibration accuracy 0.1 F°.—*Arnoux Corp., 11924 W. Washington Blvd., Los Angeles 66, Calif.*

For more information circle **266** on inquiry card.

MINIATURE THERMOSTAT



New Model 32400-0 Miniature Thermoswitch is hermetically sealed; can be temperature-set either by user or at factory; inherent sensitivity <1F°; operating temperature limits −65° F and 220° F; ratings 2.5 amp 115 vac or 2.0 amp 28 vdc.—*Fenwal, Inc., Ashland, Mass.*

For more information circle **264** on inquiry card.

TEMPERATURE CONTROLLER

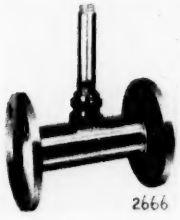
New thermocouple temperature control system eliminates errors due to stray pickup, can control to 0.1F°

using platinum thermocouple or 0.025 F° with base-metal types; is designed for saturable-core reactors.—*Minneapolis-Honeywell, Boston Div., 1400 Soldiers Field Rd., Boston 35, Mass.*

For more information circle **267** on inquiry card.

flow-rate

FLOW-RATE TRANSMITTER

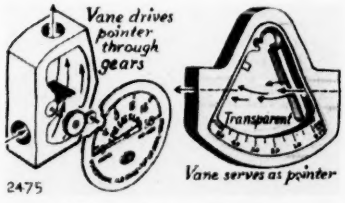


New version of Mark V Flow Transducer features housings with welded steel flanges in all nominal pipe sizes; extends application of Mark V to cover virtually any industrial flow requirement (subject only to a 10-1 range limitation on any single transmitter); has 0.5% accuracy. Standard sizes up to 4"; larger sizes (with any type of end connections) to order.—*Ramapo Instrument Co., Inc., 8 First St., Bloomingdale, N. J.*

For more information circle **268** on inquiry card.

FLOW-RATE INDICATORS

Newly enlarged and improved line of indicating flowmeters includes liquid flow instruments for pressures

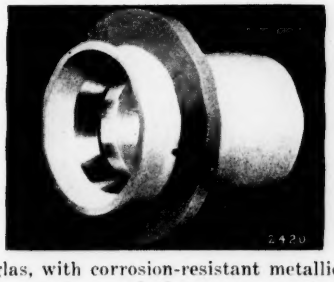


up to 2000 psig, special body materials for corrosive applications, and scale ranges from 0-6 gph to 0-6000 gph; and gas flow models with scale ranges from 0-30 cfh to 2400-60000 cfh. For ranges above 20 gpm (liquid) and 50 cfm (gas), shunt arrangements are used.—*Seico Instrument Div., Eclipse Fuel Engineering Co., Rockford, Ill.*

For more information circle **269** on inquiry card.

PLASTIC DALL FLOW TUBE

New insert-type Model DFT-PI Dall Flow Tube is made of epoxy or polyester resins, reinforced with fiber-



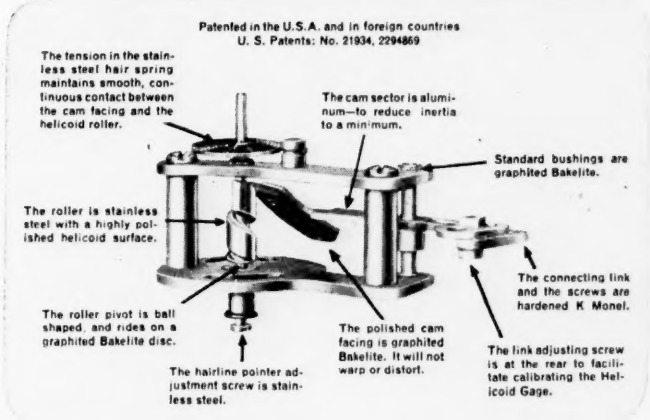
glas, with corrosion-resistant metallic throat-ring and flange; can meter "difficult" liquids and slurries with low head loss and consequent reduced pumping cost.—*Builders-Providence, Inc., 345 Harris Ave., Providence 1, R. I.*

For more information circle **270** on inquiry card.

ACCO Helicoid Gage U.S.A.

Nothing but the best in gages for working pressures from 30" vacuum to 10,000 p.s.i.

These details of Helicoid gage design assure longer life and enduring accuracy


Patented in the U.S.A. and in foreign countries
U. S. Patents: No. 21934, 2294869
The tension in the stainless steel hair spring maintains smooth, continuous contact between the cam facing and the helicoid roller.
The cam sector is aluminum—to reduce inertia to a minimum.
Standard bushings are graphited Bakelite.
The roller is stainless steel with a highly polished helicoid surface.
The connecting link and the screws are hardened K Monel.
The roller pivot is ball shaped, and rides on a graphited Bakelite disc.
The polished cam facing is graphited Bakelite. It will not warp or distort.
The link adjusting screw is at the rear to facilitate calibrating the Helicoid Gage.
The hairline pointer adjustment screw is stainless steel.

The superiority of Helicoid Gages is most evident in severe service—wherever a gage is subjected to violent pressure pulsations or severe mechanical vibrations.

The *sustained accuracy* of Helicoid Gages over *millions of cycles* is explained by the details of design and construction of the Helicoid movement shown above. Such Helicoid features—protect against wear and corrosion and assure sensitivity, sustained accuracy and trouble-free operation.

The Chemical Gage

The Helicoid Chemical Gage has a guaranteed accuracy of plus or minus 1%. It is applicable for working pressures from 30" vacuum to 5000 p.s.i. and temperatures to 400° F. It is particularly suitable for chemicals and other viscous fluids which might clog or corrode a Bourdon tube. Pressure and/or vacuum is transmitted directly to the indicating gage element through deflection of a Teflon or Kel F sealing diaphragm.

Tubes built for millions of pressure pulsations

To fit the wide range of applications, Helicoid Bourdon tubes are available in four materials —*alloy steel, K Monel, stainless* steel and phosphor bronze.

All Helicoid tubes are made from seamless tubing and are carefully designed to give maximum torque and minimum stress. When used within the dial range, they will withstand many millions of pressure pulsations and will not stretch, leak or crack.

***For complete information on the Helicoid line of gages write for* Catalog G-52**

Helicoid gives you all these features at prices that are competitive in the quality gage field.

Helicoid Gage Division
AMERICAN CHAIN & CABLE
929-B Connecticut Avenue • Bridgeport 2, Connecticut

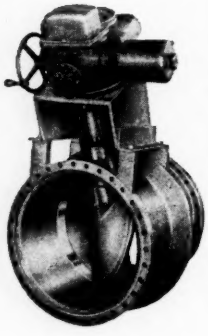
ACCO TRADE MARK

For more information on Gages circle **80**; on Tubes circle **81** on inquiry card.

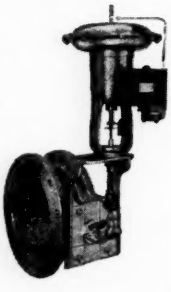
Your plant needs

ROCKWELL VALVES *like these*

"Kwikleen" slide valve for powdered coal, granular materials, flue gases with high solids content, etc.; solids accumulations easily cleaned out by removing bottom plate.



"Stress-seal" butterfly valve for tight shut-off of hot, corrosive or dirty gases to 1300° F. and higher, at 200 p.s.i. Alloy stress band in valve body is inflated by external gas pressure to effect tight seal.



Butterfly valve with simplified bracket and linkage to air operator and valve disc positioner; provides maximum adjustment, minimizes friction, eliminates backlash, chatter and hunting, reduces power requirement in close control applications.

"Slim-Jim" wafer type butterfly valve for low pressure air, gas or liquids; low cost, light, simple, space-saving, easy to install.

What's your valve problem?

W. S. ROCKWELL COMPANY
2128 ELIOT STREET
FAIRFIELD, CONN.

For more information circle **82** on inquiry card.

pressure and vacuum

PRESSURE CALIBRATORS

New improved types of pressure-pickup calibrators have absolute pressure ranges from 0-31.5" Hg to 0-150"

Hg; differential pressure ranges from 0-120" water to 0-300" Hg. Accuracy of all models is 0.1% of full-scale range; readability and sensitivity to pressure change is one part in 10,000. —*Wallace & Tiernan, Inc.*, 25 *Main St., Belleville, N. J.*

For more information circle **271** on inquiry card.

PRESSURE STANDARD

New model of Type 6-201 pneumatic dead-weight Primary Pressure Standard has a new piston-cylinder combination which extends Standard's range to 500 psi; is used with existing weight sets; requires no modification to Standard. —*Consolidated Electrodynamics Corp.*, 300 *N. Sierra Madre Villa, Pasadena, Calif.*

For more information circle **272** on inquiry card.

LOAD-CELL CALIBRATOR

New Model 104 calibrates instruments used with resistance type force and pressure cells rated on voltage

output ratio basis, by being substituted for cell. Three standard versions, with max output ratings of 0.002, 0.004, and 0.008 volt/volt. Voltages are guaranteed to be within 0.1% of rating between 40° F and 100° F.—*Gilmore Industries, Inc.*, 13015 *Woodland Ave., Cleveland* 20, *Ohio.*

For more information circle **273** on inquiry card.

AUTOMATIC PRESSURE LOGGER

New Type 5 Data-Master scans sequentially 24 or 48 pressure lines into a single measuring element, with extremely low (0.1 cu in) switched volume; achieves high accuracy (0.25%) pressure measurements by minimizing air flow disturbance at probe orifice, pressure drop at probe orifice and in pressure lines. Output data can be presented on both punched tape and typewriter in suitable form for computer or tape-to-card converter entry. Scanning rate 4 points per second; range 0 to 350 psia, psig or psid.—*Hanson-Gorrill-Brian, Inc.*, 85 *Hazel St., Glen Cove, N. Y.*

For more information circle **274** on inquiry card.

U-TUBE MANOMETER

New Series A features compactness, low cost, and unbreakable plastic tubing construction: no problems of broken glass tubes and gaskets. Fittings can be entirely eliminated by special arrangement. Sizes: 8", 20", and 35".—*Jerber Engineering Co.*, 2334 *Secane Rd., Secane, Pa.*

For more information circle **275** on inquiry card.

DUAL PRESSURE SWITCH

New Type J96A explosion-proof dual-switch pressure control, for use in hazardous locations where explosive vapors or gases are present, has two separate switches, permitting independent switch action above or below set point, control of two independent circuits and flexibility of switching arrangement.—*United States Controls Co.*, 79 *School St., Watertown, Mass.*

For more information circle **276** on inquiry card.

ABSOLUTE PRESSURE PICKUP

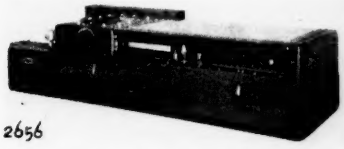
New Model 409, available in ranges from 0-2 psia to 0-100 psia, is said to have extremely accurate noise-free performance at 15 G up to 2000 cps; features maker's Ni-Span-C aneroid-type capsule, and temperature compensation from −65°F to 200°F; is available with outputs which are linear (with pressure or altitude) or functional, or with tapped pots, etc. —*Bourns Labs., Inc., P. O. Box* 2112, *Riverside, Calif.*

For more information circle **277** on inquiry card.

weighing

BELT STREAM WEIGHER

New Pneu-Weigh meets needs of continuous process industries for measurement and control of flow of



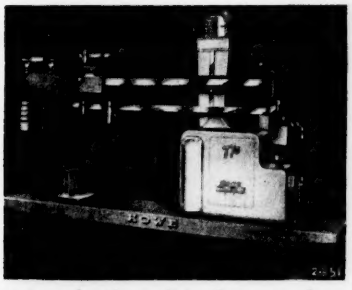
2656

dry materials at low to medium rates (<3000 lb/min); operates over a 10:1 range (convertible to 50:1 by maker's variable-speed belt drive). Accuracy 0.5% of maximum rate. Among features: positive chain drive; continuous integration which totalizes correctly regardless of belt speed.—*Omega Machine Co., 345 Harris Ave., Providence 1, R. I.*

For more information circle **278** on inquiry card.

PROJECTION TYPE SCALE

New improved version of Weightograph projects actual weight on eye-level illuminated screen, with figures

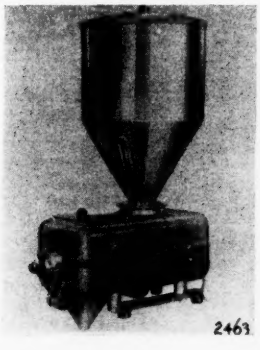


and graduations all in the same plane, preventing parallax errors when read from an angle. Weights clearly visible even in direct sunlight. Available models include one with weight indication projected on both sides.—*Howe Scale Co., Rutland, Vt.*

For more information circle **279** on inquiry card.

GRAVIMETRIC BATCHER

New Filamatic Net Weighing Machine automatically net weighs and dispenses into containers any free-



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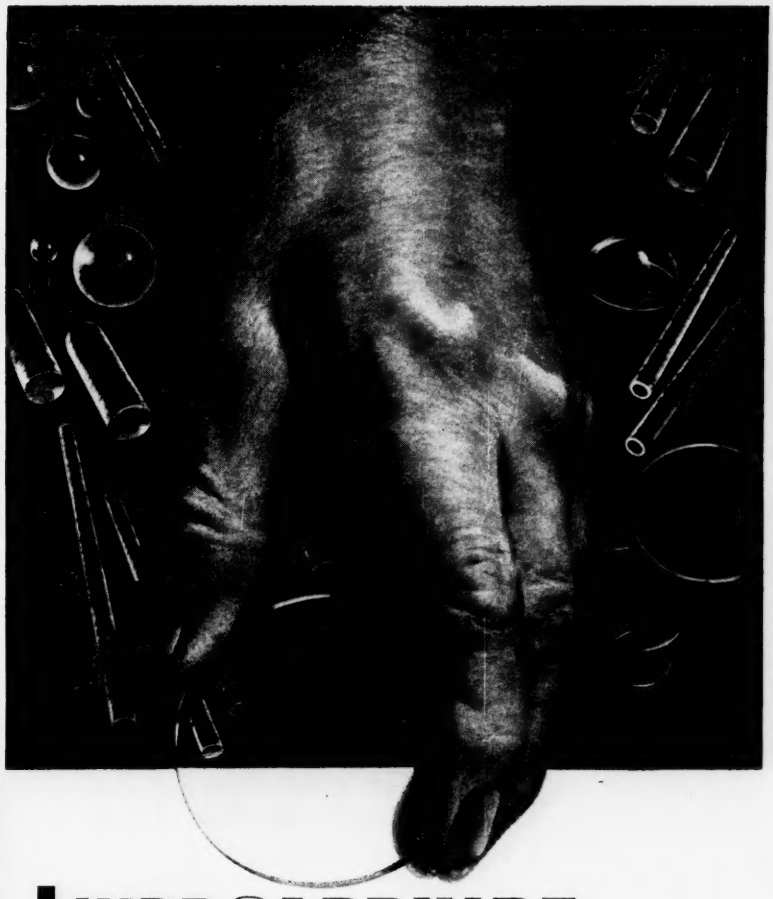


LINDE SAPPHIRE...

SHAPED TO YOUR NEEDS

Single-crystal sapphire is produced by LINDE in many shapes for a wide variety of applications. Common shapes include windows, balls, rods, and tubes. Special shapes are supplied to order.

LINDE sapphire is transparent, non-porous, and has excellent ultra-violet and infra-red transmission characteristics. Infra-red transmission is 92% at 3 microns, 50% at 6 microns (1 mm thickness). Typical uses are as windows, spacers, and supports in electronic tubes; for light pipes; and for ultra-violet and infra-red devices. High- and low-temperature seals can be made to metals as well as to glass and ceramics.

Inquiries regarding mechanical, optical, thermal, and electrical properties of LINDE sapphire are invited. Write Crystal Products, Dept.1A-6,LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. *In Canada:* Linde Company, Division of Union Carbide Canada Limited.

Linde TRADE-MARK UNION CARBIDE

The terms "Linde" and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

For more information circle **83** on inquiry card.

Endurance RATED COUNTERS

Stroke and Revolution Counters for the *Toughest* Jobs

- **200 Million Count Life**
- Rugged, oversize shaft and bearings
- Shakeproof—only one screw in counter assembly.
- All steel housing with snap-on cover—chrome plated.
- Reliable — no skip or over-count.
- Tamperproof reset.

Thousands used in Automobile and Aircraft factories; in stamping, metal working, die casting and plastic molding plants; in foundries, printing plants and factories.

PIC-600 Electric Counters

Basemount
Knob reset

- **50 Million Count Life**
- 7 watts power consumption—operable in plate circuit of electronic tubes.
- 1000 CPM rating—reliable to 1600 with suitable actuation.
- Quiet—no AC hum.
- Balanced armature—for reliability on airborne equipment.

Also endurance rated counters for all purposes. See your PIC Distributor or write for catalog.

Production Instruments
DIVISION OF GENERAL CONTROLS CO.
8062B McCormick Blvd., Skokie, Ill.

42 Branch Offices and Representatives serving USA and Canada

For more information circle **84** on inquiry card.

NEW INSTRUMENTS

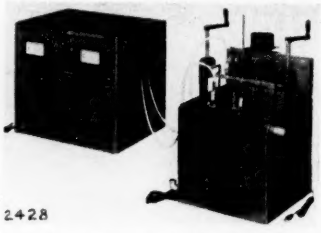
flowing non-liquid product that will pass through a hopper: materials as dissimilar as powders, seeds, tablets and tacks. No stirrers or agitators and no mechanical cut-off, therefore no crushing or damage to products. Working mechanism is enclosed to assure dust-free dispensing. Speed selector knob for 0 to 15 weighings per minute. Accuracy of fill 1%.—*National Instrument Co.*, 2701 *Rockwood*, *Baltimore* 15, *Md.*

For more information circle **280** on inquiry card.

shop equipment and supplies

CHROME PLATING UNIT

New Model A #75 Chromplater will deposit from 0.0001" to 0.010" of chrome on tools, shafts, gears, and on



2428

all types of worn steel, cast-iron or non-ferrous metals.—*The Dawson Corp.*, 302 *Fifth Ave.*, *Pelham*, *N. Y.*

For more information circle **281** on inquiry card.

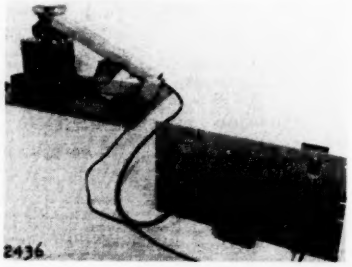
WIRE SAMPLE BOARD

New sample board with actual samples of maker's more popular hookup and lead wires for commercial electronic equipment and components includes samples of UL-approved and Canadian Standards Ass'n approved wires and Lenz small diameter miniature lead wires. Free to engineers and purchasing agents.—*Lenz Electric Mfg. Co.*, 1751 *No. Western Ave.*, *Chicago* 47, *Ill.*

For more information circle **282** on inquiry card.

SMALL-PARTS COUNTER

New Model ZA-701 Industrial Parts Counter, for batch counting of small parts such as machine screws, rivets,



2436

washers, etc., will count any item which can be passed through a light beam. When preset number is reached, unit provides a 110-vac signal to command parts-handling equipment.—*Electronic Engineering Co.*, 1601 *E. Chestnut Ave.*, *Santa Ana*, *Calif.*

For more information circle **283** on inquiry card.

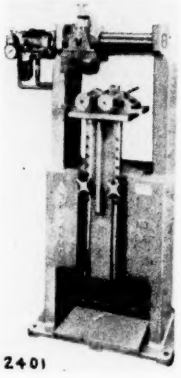
SMALL-PARTS COUNTER

New high-speed Triumph Electronic Counter for counting tablets, pills, capsules, beads, etc., removes dust and chips automatically; does not mark or damage tablets; is easily operated by unskilled personnel; is practical for counting small batches of 50 bottles or less. Three models: TB2 single-head counter, rate of 1200 to 1500 per minute; TB3 double-head machine with about twice production of TB2; TB4 single-head machine handling larger tablets up to 1" with same production as TB2.—*The Burnet Co.*, *E. Midland Ave.*, *Paramus*, *N. J.*

For more information circle **284** on inquiry card.

METAL MARKING MACHINE

New Model 9AP, powered from plant air line (75 psi and up), has open type of back and offset front to permit marking continuous strip, rod, etc., and to fit into any production line. Illustration shows marking head holding an automatic numbering machine and a solid marking die for lettering.—*The Acromark Co.*, 543 *Morrell St.*, *Elizabeth*, *N. J.*



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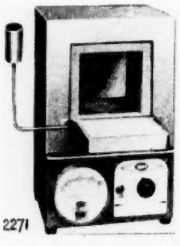
For more information circle **285** on inquiry card.

ELECTRIC BENCH FURNACES



2271

Four new Type 1300 utility-size electric bench-type furnaces, added to Temco line, all have the same chamber dimensions and temperature limits (1650°F continuous, 1900°F intermittent) but differ in voltage requirements (115 or 230) and in modes of temperature control: continuously-variable or 5-position.—*Thermo Electric Mfg. Co.*, 511 *Huff St.*, *Dubuque*, *Iowa.*

For more information circle **286** on inquiry card.

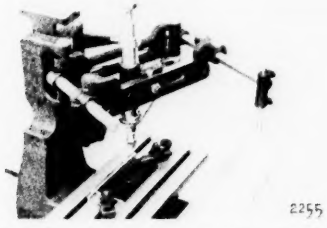
RADIUS TURNING MACHINE

New precision machine originally designed to turn plastic contact lenses is ideal for instrument work; can turn concave or convex radii up to 1"; has longitudinal slide in addition to slide used for turning. Thus, tool can be fed into work without altering radius for which it is set. Standard Levin lathe headstock has collet capacity of either ⅜" or ½".—*Louis Levin & Son, Inc., 3610 So. Broadway, Los Angeles 7, Calif.*

For more information circle **287** on inquiry card.

DRILL ATTACHMENT

New quick-action drill attachment for Model UE-3 Panto Engraver enables operator to drill any number

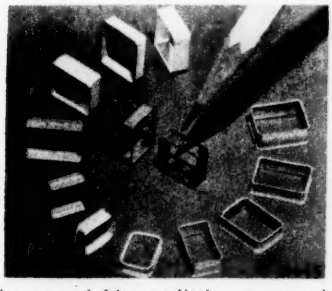


of holes from an accurate master template. Vertical spindle travel 1"; depth of feed controlled to thousandths; two precision drill chucks hold drills from 0.008" to 0.062" or from 0.025" to 0.125"; pantograph reduction ratios from 1.6:1 to 7:1.—*H. P. Preis Engraving Machine Co., 226 Industrial Branch, U. S. Highway 22, Hillside, N. J.*

For more information circle **288** on inquiry card.

MOVING-COIL FORMS

New precisely-dimensioned anodized moving coil forms for d'Arsonval galvanometers come in various sizes and

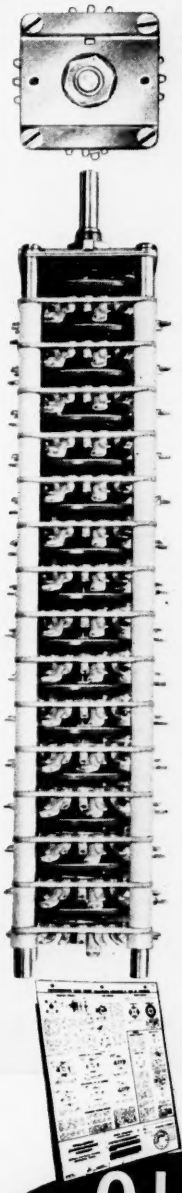


shapes, weighing as little as one grain (1/480 oz). Tolerances as close as 0.0002" can be obtained on wall thicknesses from 0.003" to 0.010". Tolerances on other dimensions can be within 0.001". Anodized coating can be dyed so that user can distinguish forms differing only slightly in size. Standard material is ultra-high purity aluminum (99.8% with 0.015% maximum iron content).—*H&H Machine Co., Inc., Noble & Jackson Sts., Norristown, Pa.*

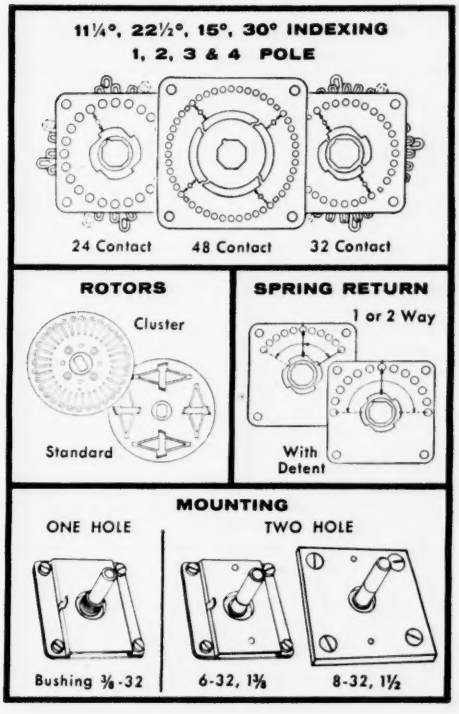
For more information circle **289** on inquiry card.

NEW Compactness . . . *NEW* Versatility in

ROTARY SWITCH DESIGN



SHALLCROSS *Miniature* ROTARY SELECTOR SWITCHES give the long-lasting dependability of multi-leaf wiper, button-contact design . . . *and* the added advantages of compactness and new versatility. The sketches below detail some of the many unusual features of this new switch series . . .



ELECTRICAL SPECIFICATIONS: Operating Voltage—to 2000 volts; Breakdown Voltage—to 3000 volts; Breaking Current—5 amp @ 125 V. ac.; Carrying Current—15 amp.

Write for complete specifications on the new Shallcross "Miniature Series".

Shallcross

New Address

SHALLCROSS MANUFACTURING COMPANY, Selma, N. C.

For more information circle **85** on inquiry card.

BOURDON TUBING

ACCURATE ONE INCH TO ONE MILE

Constant wall thickness . . . consistent spring properties . . . exact duplication . . . whether a "C", a helix, or a spiral—Precision Bourdon Tubing meets all these requirements. Precision's modern production facilities offer you instrument tubing to meet your most exacting specifications—tubing preformed or straight.

Precision also offers Coaxitube, a metal shielded wire consisting of an inner conductor, insulation and seamless non-ferrous metal tubular shield forming a coaxial pair of conductors. Semi-rigid equivalents to all RG/U cables.

Write for full details on "Precision Tubing For Precision Instruments" to Dept. 3, Precision Tube Corporation, North Wales, Pa.

For more information circle **86** on inquiry card.

inspection and gaging

PROJECTOR ACCESSORIES

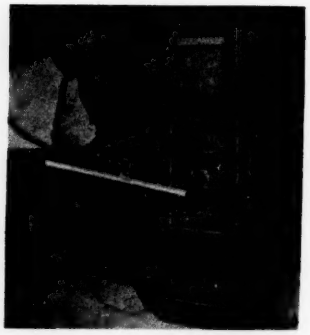
Two new accessories enhance versatility of maker's Contour Projectors: (1) Power Elevation Unit for smooth,

rapid, vertical table settings; (2) Hi-Intensity Surface Illumination Unit for surface projection of parts with irregular and diffuse surfaces.—*Eastman Kodak Co., Rochester* 4, *N. Y.*

For more information circle **290** on inquiry card.

ULTRASONIC GAGE

New rack-mounted Model R Vidigage for ultrasonic thickness gaging, detection of laminar flaws, etc., has



connections for automatic sorting and rejection.—*Branson Instruments, Inc., 40 Brown House Rd., Stamford, Conn.*

For more information circle **291** on inquiry card.

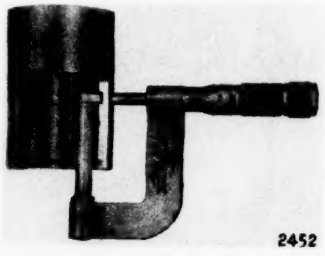
JIG BORER MICROSCOPE

New instrument of Leitz-Wetzlar (West German) make has been specially designed as a locating 'scope in precision machine tools. Its eyepiece is adjustable for individual focusing.—*Opto-Metric Tools, Inc., 137 Varick St., New York* 13, *N. Y.*

For more information circle **292** on inquiry card.

INNER-GROOVE MIKE

New Imp micrometer comes with two interchangeable anvils: for narrow retaining-ring grooves and for



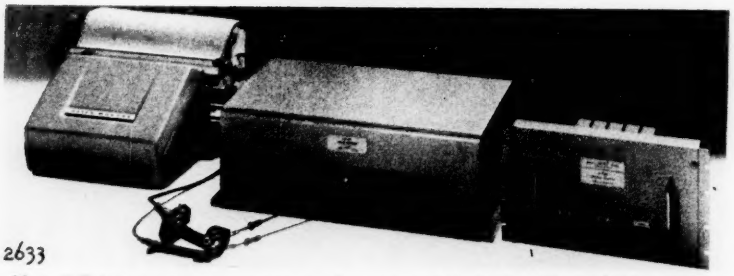
O-ring grooves. (Other interchangeable anvils in widths up to 0.230".) Grooves can be measured in bores as small as 15/32" and to a depth of 2" from face.—*Illinois Metal Products, 429 W. Superior St., Chicago* 10, *Ill.*

For more information circle **293** on inquiry card.

LAYOUT-INSTRUMENT SCALE

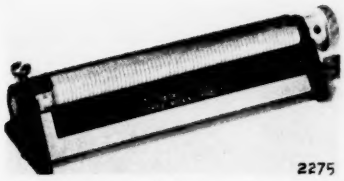
New Micro-Scale is a simple dimensional standard for precision setting of layout instruments; permits setting dividers, etc., to 3-decimal accuracy

LINEAR ENCODER SYSTEMS



New LE-100 systems measure and record lengths from 0 to 100 feet in 1/8", 1/16", or 0.001" increments; rate depends on recording device: about 2 readings a second with a Datex-Monroe Data/Log. If desired, total in feet and inches of individual pieces measured can be recorded on command.—*G. M. Giannini & Co., Inc., 918 E. Green St., Pasadena* 1, *Calif.*

For more information circle **294** on inquiry card.



2275

without gage blocks or other standards.—*Trico Machine Products Corp., 2664 Grand Ave., Cleveland 4, Ohio.*

For more information circle **295** on inquiry card.

mechanical testing

RUBBER HARDNESS TESTER

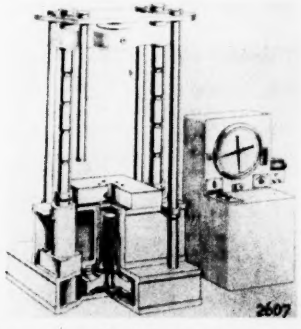
2672

New Shore A-2 Durometer for testing indentation hardness of elastomers (ASTM D676-55T) with tolerance hands (Code XATH) has tolerance hands that can be set by two knurled knobs and are of visual assistance where a large number of parts in a specific hardness range are to be tested.—*The Shore Instrument & Mfg. Co., Inc., 90-35 Van Wyck Expressway, Jamaica 35, N. Y.*

For more information circle **296** on inquiry card.

TESTING MACHINE

New 150,000-lb universal testing machine (largest single-screw mechanical type) can apply tension and

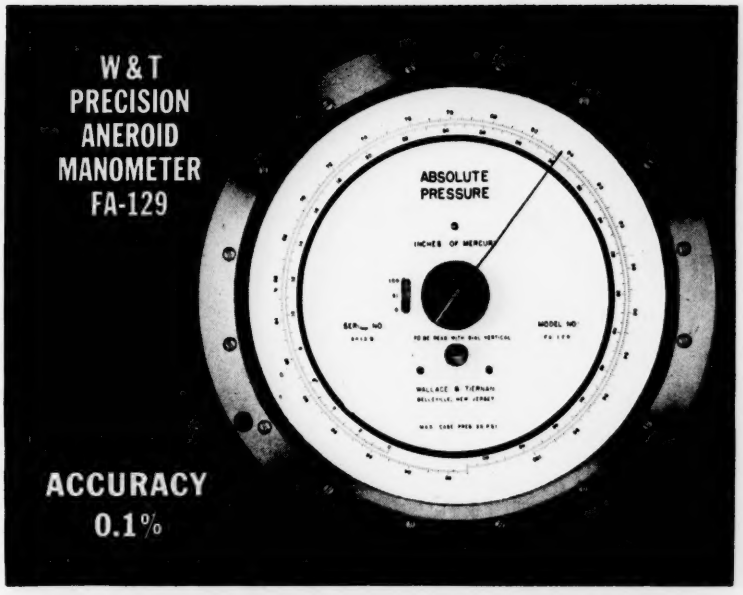


2607

Cutaway view. Notched columns are working columns; table is connected to ram-type assembly attached to ball-screw nut; rotation of bull gear turns screw which, in turn, moves ball nut.

compression or alternating loads to a specimen; utilizes SR-4 devices for all measurements; incorporates unique single preloaded ball-and-screw mechanism for head movement (rather than conventional Acme or square-thread screws) and other new construction features.—*Baldwin-Lima-Hamilton Corp., Philadelphia 7, Pa.*

For more information circle **297** on inquiry card.



PRECISE CALIBRATING STANDARD
...For Absolute Pressure Work

Ranges: 0 to 31.5 inches of Hg. absolute (min.)
0 to 100 inches of Hg. absolute (max.)
Other intermediate ranges available

Accuracy: 1/1000 of full scale

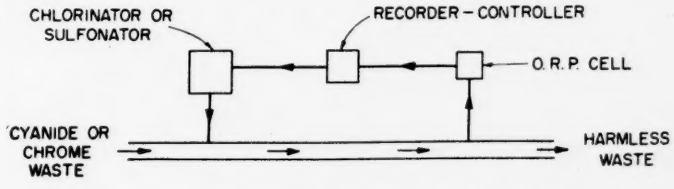
Sensitivity: 1/10,000 in *all* ranges

Scale Length: 45 inches in two revolutions

Dial Size: 8½ inch diameter

Write for Publication No. TP-15-A

WALLACE & TIERNAN INCORPORATED
25 MAIN STREET, BELLEVILLE 9, NEW JERSEY
In Canada, Wallace & Tiernan, Ltd. — Toronto A-112



An oxidation-reduction potential cell, monitoring treated waste provides the signal for recording and controlling treatment chemical quantities in a typical W&T waste treatment system.

For Full information on Industrial Waste treatment write Dept. I-66.00

WALLACE & TIERNAN INCORPORATED
25 MAIN STREET, BELLEVILLE 9, NEW JERSEY
In Canada, Wallace & Tiernan, Ltd. — Toronto

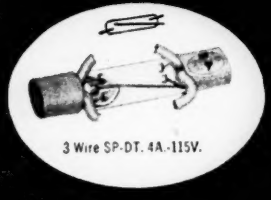
For more information circle **87** on inquiry card.

MERCOID

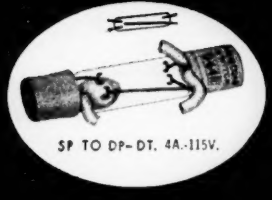
HERMETICALLY SEALED

MERCURY SWITCHES

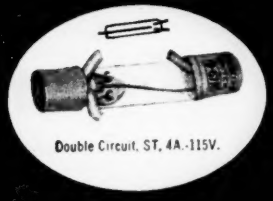
TILTING TYPE AVAILABLE CIRCUITS



3 Wire SP-DT. 4A.-115V.



SP TO DP-DT. 4A.-115V.



Double Circuit, ST, 4A.-115V.

SP-ST. 10A. 115V.
SP-ST. 25A.-115V.

Actual Size

SPST 1.75 amp. 115 volts metallic-end caps

Many standard Mercoid switches are available write for Bulletin –54

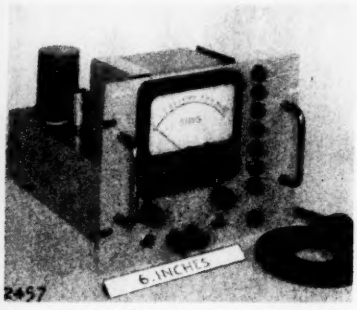
THE MERCOID CORPORATION
4201 BELMONT AVE., CHICAGO 41, ILL.

For more information circle **88** on inquiry card.

electrical testing

AUTOMATIC OHMMETER

New KT 427879-1 permits high volume testing of resistance or continuity; features automatic range switch-



ing, visual indication of resistance at output terminals, fast response, and range switching by a servo loop which selects correct range to insure mid-scale indication for any resistance value: selected multiplier is clearly indicated.—*Kearfott Co., Inc.*, 1378 *Main Ave., Clifton, N. J.*

For more information circle **298** on inquiry card.

NOISE FIGURE METER

New automatic Model 501 for traveling wave tubes operates at 30 Mc input with sensitivity sufficient

to measure TWT noise figure without external amplification. In addition, a test facility for system errors is employed for the first time in an automatic noise figure meter.—*Brocker Laboratories, Box 967, Sunnyvale, Calif.*

For more information circle **299** on inquiry card.

TACHOMETER-VOM

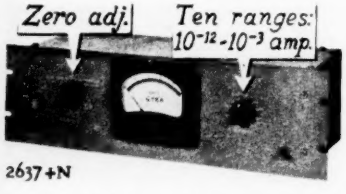
New Speedvolter not only indicates speed but enables technicians or maintenance personnel to troubleshoot equipment by voltage and resistance checks. It has a highly linear tachometer generator, also a high-quality voltmeter and ohmmeter; all so protected that burn-outs are virtually impossible.—*Servo-Tek Products Co., 1086 Goffle Road, Hawthorne, N. J.*

For more information circle **300** on inquiry card.

electrical and electronic instruments

ELECTROMETER

New Model E-100 features reliability and quick response, as well as accuracy of 3% on 10^{-3} to 10^{-11} amp



ranges and 5% on 10^{-12} amp range; drift stabilized to <2% per week on 10^{-11} and higher ranges; high stability from doubly-regulated electrometer tube; 100-mv recorder output. —*Gyra Electronics Corp., 518 N. Spring Ave., La Grange Park, Ill.*

For more information circle **301** on inquiry card.

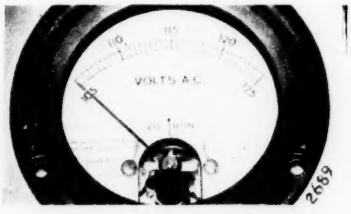
GALVANOMETER

New CG-25 galvanometer features vertical and horizontal spot adjustment, ruggedness, variable factor as low as 1% (competitive instruments said to vary from 5% to 10%), and stab-type contact which eliminates connecting and disconnecting lead wires. Static and dynamic balancing of instrument elements minimizes response to vibrations and sudden acceleration.—*Oxley Co., 6338 Washington Ave., Houston, Texas.*

For more information circle **302** on inquiry card.

EXPANDED SCALE VOLTMETERS

New line of voltmeters features exceptional readability and 0.5% accuracy which is maintained without



heaters or ovens over military temperature range of −55°C to 65°C and from 50 to 2000 cps; negligible change from original calibration for more than 1 year; meets all requirements of MIL-M-10304; comprises ac and dc types; military types in $2\frac{1}{2}$", $3\frac{1}{2}$" and $4\frac{1}{2}$" round sizes; industrial types in $2\frac{1}{2}$" and $3\frac{1}{2}$" round or square, or 4" x 6" rectangular.—*Voltron Products, 1010 Mission St., S. Pasadena, Calif.*

For more information circle **303** on inquiry card.

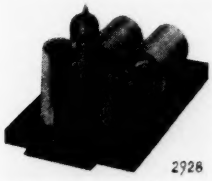
electrical-instrument accessories

GALVANOMETER AMPLIFIER

New Model GGA-2 contains four output amplifier channels which, in conjunction with four GFD-2 discriminators, permit driving HF galvanometers to their deflection limits. It changes output voltage range of associated GFD-2 discriminators to ±5 v max at 100 ma (GFD-2 specs changed). Four channels are included in a single package. Size 5¼" h, 12" w, 16½" d.—*Data Control Systems, Inc., 39 Rose St., Danbury, Conn.*

For more information circle **304** on inquiry card.

AUTOMATIC GAIN CONTROL



New Model DLA-30 AGC Unit, mounted on 3½" x 6" plug-in printed circuit chassis, maintains constant servo loop gain for reference voltage variations from 2 to 100; functions as a variable plate load when used in conjunction with DLA-10 Servo Preamplifier.—*Electro Precision Corp., P. O. Box 669, Arkadelphia, Ark.*

2928

For more information circle **305** on inquiry card.

PRECISION VOLTAGE SOURCES

New rack-mounted Model VR-608 Precision Voltage Reference Sources have five decade switches for selection of precise voltages from −111.112 vdc to +111.112 vdc in 1-mv steps and a vernier control for interpolation to nearest 0.1 mv. Units are equipped with a front panel null indicator. Absolute accuracy 0.01%; stability 0.05%. Output impedance essentially zero ohms. In addition to selectable output, there are 2 absolute reference outputs: −100.000 vdc and +100.000 vdc.—*Epsco, Inc., 588 Commonwealth Ave., Boston 15, Mass.*

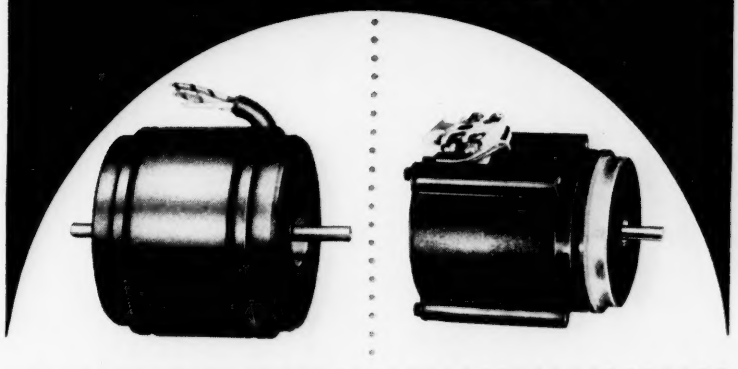
For more information circle **306** on inquiry card.

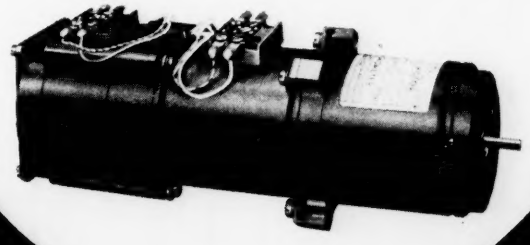
SUBMINIATURE AMPLIFIER

New Model 207S high-temperature medium-gain silicon transistor voltage amplifier for servo, audio and pulse applications has 20-db closed-loop ac gain, stable within ±10% from −60°C to 160°C. No microphonic noise observable up to 400*G* at 2000 cps. Operates from 28 v supply.—*Taber Instrument Corp., N. Tonawanda, N. Y.*

For more information circle **307** on inquiry card.

DIEHL*
Servo Package





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For more information circle **89** on inquiry card.

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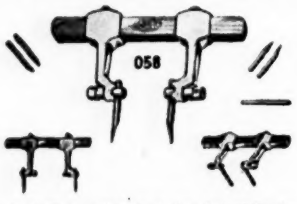

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For more information circle **103** on inquiry card.

Process Control

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Reason: it combines for the first time the practical "how" and the theoretical "why."

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electrical and electronic components

TRANSISTOR TRANSFORMERS

New TT Style transformers for transistor circuitry have interlayer insulation between windings of thin-

nest practical material consistent with wire sizes, in order to minimize leakage inductance. Units are safely rated at 200 vdc, 125°C; meet MIL-T-27a requirements.—*PCA Electronics, Inc.*, 16799 *Schoenhorn St., Sepulveda, Calif.*

For more information circle **308** on inquiry card.

SILICON RECTIFIER

New sealed silicon rectifiers feature efficiency of about 99%; freedom from aging effects; ability to operate at high temperatures; greatly reduced space needs and low cost. Eight smaller models (500 ma to 5 amp) are threaded on each end so they can be screwed into chassis for heat sink, coupled together in series, or plugged into clip holders. Larger units rated from 25 amp have a bolt-down base and pigtail connection.—*Audio Devices, Inc., 620 E. Dyer Rd., Santa Ana, Calif.*

For more information circle **310** on inquiry card.

HIGH-RESOLUTION VDRs

New Models 1437 (1⅝") and 1750 (1¾") standard precision voltage-dividing resistors can be supplied singly or as externally-phaseable ganged units; feature availability of a wide range of special electrical features. Standard resolution for Model 1437 is as high as 3900 wires, with a resistance range from 100 to 160,000 ohms. Model 1750 resolution to 5000 wires and resistance from 100 to 300,000 ohms. Standard linearity range for both units is 0.5% to 0.1%. —*G. M. Giannini & Co., Inc.*, 918 *E. Green St., Pasadena* 1, *Calif.*

For more information circle **309** on inquiry card.

SOLID-STATE CHOPPER

New Model 50 utilizes a pair of matched transistors that are alternately switched on and off; can be

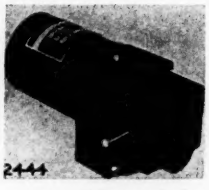
used as a chopper, as a demodulator, etc.; withstands 500-*G* shock and 700-*G* acceleration; operates between −40° C (−40° F) and 80° C (176° F).—*Solid State Electronics Co.*, 8158 *Orion Ave., Van Nuys, Calif.*

For more information circle **311** on inquiry card.

electromechanical components

RIGHT ANGLE MOTOR

New line of gear reduced motors with right angle drives feature quiet, long-life operation without need of frequent lubrication. Entire assembly weighs about 22 oz. Illus.: Type FC (1.675" OD) operating on 115 vac 60 cps single-phase or 220 vac 60 cps 3-phase; can be furnished as a hysteresis-synchronous or induction type.—*Globe Industries*, 1784 *Stanley Ave., Dayton* 4, *Ohio.*



For more information circle **312** on inquiry card.

AUTOMATIC CLOCK

New Type EC industrial battery-driven clock, guaranteed to run automatically for two years without winding or charging battery, has been designed for remote field stations; is waterproof, chemically-resistant and finished to MIL specs.—*PIC Design Corp.*, 477 *Atlantic Ave., East Rockaway, L. I., N. Y.*

For more information circle **313** on inquiry card.

TELEPHONE-TYPE RELAY

New miniature Class E, though weighing only 2 to 3 oz, incorporates best features of its Class B predecessor; has life expectancy of 100 million to 200 million operations. Improved terminal spacing makes all terminal rows readily accessible.—*Automatic Electric Co., Northlake, Ill.*

For more information circle **314** on inquiry card.

TELEPHONE-TYPE RELAY

New miniature Series AA is designed for use in electronic circuitry, computers and industrial control equipment requiring highest reliability and longest service life; has a hydrogen-annealed magnetic structure and more contact pressure, offers

increased efficiency of operation and greater reliability than previous models; is thoroughly tested during every step of manufacture.—*Automation Controls Corp.*, 5737 *W. 58th St., Los Angeles* 45, *Calif.*

For more information circle **315** on inquiry card.

SERVO BRAKE

New Model B F Servo-mounted Electro-magnetic Brake, when energized, allows output shaft to rotate free; when not energized exerts braking action, thus allowing a servo-motor to be braked with power on ready for immediate response. It can be used also to lock one output shaft of a differential gear while other output is transmitting a controlled motion. Four sizes, with minimal brake torques of 2, 4, 8 and 32 ounce-inches. All meet MIL-E-5272A vibration requirements.—*Autotronics Inc., Rt.* 1, *Box* 812, *Florissant, Missouri.*

For more information circle **316** on inquiry card.

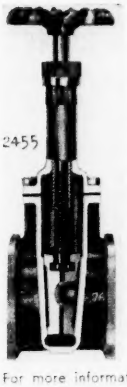
valves & actuators

60,000-LB AIR-OP VALVES

New Remarco air-operated valve is for on-and-off service in line operation. With 6 to 30 psi of instrument air, valve operation delivers up to 1500 lb force. Available in three modes of operation: (1) air to open, spring to close; (2) spring to open, air to close; (3) air to open, air to close.—*High Pressure Equipment Co., Inc.*, 1222 *Linden St., Erie, Pa.*

For more information circle **530** on inquiry card.

GATE VALVE



New No. 76 features 125-psi aluminum body and Nylon seating discs which assure tight shut-off, even in presence of dirt or grit. No dissimilar metals, so no possibility of electrolytic corrosion. Available now in 3" screwed end size; other sizes soon.—*Jordan Industrial Sales Div., OPW Corp.*, 6013 *Wiehe Rd., Cincinnati* 13, *Ohio.*

For more information circle **317** on inquiry card.

SLOW-CLOSING VALVES

Newly-redesigned non-shock slow-closing Loading Valves, available in 125-psi bronze and aluminum, sizes

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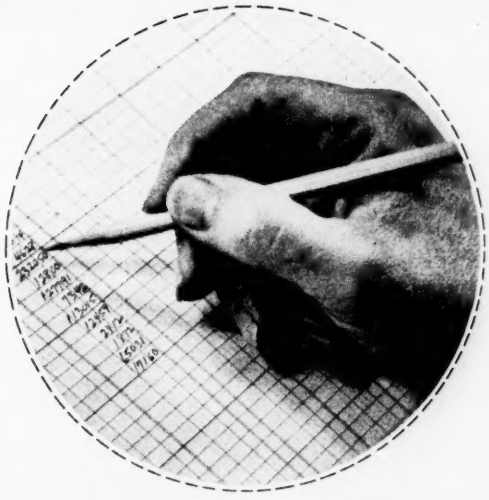

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For more information circle **91** on inquiry card.

Here's information you'll want on STANDARD precision timers

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S-100	1/5 sec.	6000 sec.	±.1 sec.
S-60	1/5 sec.	60 min.	±.1 sec.
SM-60	1/100 min.	60 min.	±.002 min.
S-10	1/10 sec.	1000 sec.	±.02 sec.
S-6	1/1000 min.	10 min.	±.0002 min
S-1	1/100 sec.	60 sec.	±.01 sec.
MST	1/1000 sec.	.360 sec.	±.001 sec.
MST-500	1/1000 sec.	30 sec.	±.002 sec.

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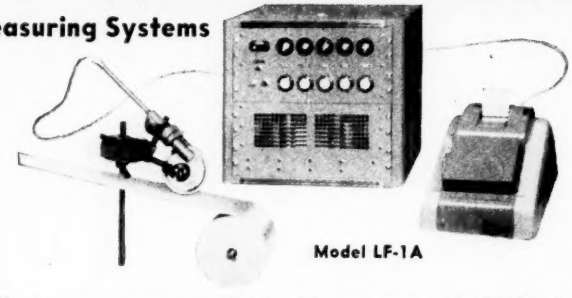
For more information circle **92** on inquiry card.

POST DECITRON ELECTRONIC PRODUCTS

Measuring Systems



Model LF-1A

Now! . . . a permanent record of lineal footage. The Post LF-1A Lineal Footage System combines the accuracy of proven electronic equipment with a visual "Clary" readout.

Ideal for accurate measurement for manufacturers of wire, paper, textiles and sheet metals. Sensing elements can be furnished so that measurements can be made in 1/16ths of an inch, 1/8ths, 1/4ths or in full inch increments.

Write for literature.

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For more information circle **93** on inquiry card.

NEW INSTRUMENTS

2" to 6", flanged and screwed end models, prevent piping system damage caused by too-fast shut-off of flow; obviate need for surge chambers. Initial closure movement is fast, final closure is gradual. Closing speed easily adjusted in field.—*Jordan Industrial Sales Div., OPW Corp.*, 6013 *Wiehe Rd., Cincinnati* 13, *Ohio.*

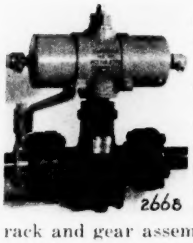
For more information circle **318** on inquiry card.

TWO-WAY SOLENOID VALVE

New R Series pilot-operated piston valve makes available a normally-open or normally-closed valve with 1/4" orifice and 1/4" NPT and ability to handle pressures from 5 to 200 psi. Available soon will be a high-pressure version (to 1000 psi and higher).—*Skinner Electric Valve Div.*, 105 *Edgewood Ave., New Britain, Conn.*

For more information circle **319** on inquiry card.

ACTUATOR

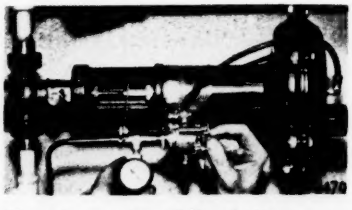


New low-cost gas- or liquid-operated Robot-arm Valve Actuator for operation of plug valves and other 90° rotating mechanisms features an oil-bath-immersed piston rack and gear assembly; can be field-installed in minutes. Standard models generate torques from 3000 to 25,000 pound-inches with 100 psi operating pressure.—*Research Engineering Co., Houston, Texas.*

For more information circle **320** on inquiry card.

PNEUMATIC POWER RELAY

New Sta-Put Relay permits open-to-close range of a pneumatic valve to be easily adjusted between 2 and



13 psi by moving sliding button on relay's lever. Another simple adjustment permits various starting points between 2 and 15 psi. Relay attaches to valve with ordinary screwdriver and wrench.—*Powers Regulator Co.*, 3434 *Oakton St., Skokie, Ill.*

For more information circle **321** on inquiry card.

miscellaneous

EVAPORATOR

New SC-2 High Vacuum Evaporator has been expressly designed for lab and pilot-plant selenium and germanium deposition, base plating of crystals, carbon evaporation, vacuum metallizing, optical coating, etc.—*Vacuum Equipment Div., New York Air Brake Co., Camden, N. J.*

For more information circle **322** on inquiry card.

DRY PROCESS WHITEPRINTER

New Lancer quiet 45" 75-fpm 100 watts per inch fully-automatic dry process whiteprinter includes new exclusive features not previously available in 42" machine.—*P & H Sales Corp., 5650 N. Western Ave., Chicago 45, Ill.*

For more information circle **323** on inquiry card.

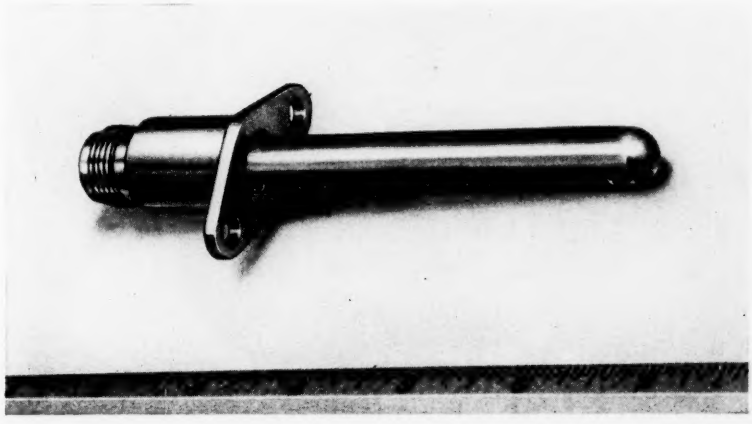
TIME LAPSE DRIVE UNIT

New Model 1325 for use with Ciné Kodak Special I or II features complete flexibility of operation; can be externally pulsed at random intervals, or synchronized automatically with any event which can be made to close a switch. Ciné Kodak Special's variable shutter control can be used to vary exposure times. Camera film chamber can be removed or reattached without dismounting camera.—*Electro-Mechanical Development Co., 2337 Bissonnet, Houston, Texas.*

For more information circle **324** on inquiry card.

New Thermocouple Measures Up To 3600° F. Without Water or Air Cooling

Designed For Jet Engine Afterburners, Ramjet and Rocket Exhausts



A new, high temperature thermocouple probe, developed by Thermo Electric, promises to solve several serious problems of airborne or test stand temperature measurement. This probe was designed for use in the high velocity gas streams of jet engine afterburners, and ramjet and rocket exhausts. The key to its performance is a cermet (ceramic-metal combination) support tube and radiation shield.

This support tube replaces the need for water or air cooling. As a direct result, conduction errors due to cooling are eliminated and radiation losses to cold duct walls are reduced about 60%. Other disadvantages of water cooling—water supply, conduit, additional space needs, and other installation difficulties, are also eliminated. Equally important are the probe's conductors—Platinum 6% Rhodium Platinum 30% Rhodium up to 3000°F. and Iridium/Iridium Rhodium up to 3600°F. Thermo Electric's initial objective with this probe was a life in excess of five hours at temperatures of 3000°F. or higher. It has already been tested at 3000°F. in a Mach 1 gas stream for 1½ hours without failure. Tests are still under way to determine the ultimate operating limitations of the probe's structural elements.

Other Applications

Possible applications of this type of unit, however, are much wider in scope. Both construction and conductors can be varied to meet a great variety of temperature measuring problems. The support tube itself, for example, can be formed to almost any shape. Other tube materials are also being investigated.

If you'd like further information on this thermocouple and how it can be adapted to your particular needs, contact Thermo Electric. Its development is typical of T-E's continuous progress in the field of high temperature measurement. Our extensive research and engineering facilities provide a complete service for the aircraft industry. Call on us. The answer to your problem may be waiting for you.

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For more information circle **94** on inquiry card.

"DELANIUM" GRAPHITE BURST DISCS... FOR RELIABLE LOW-COST PERFORMANCE

After 30,000 cycles at 75% of rated pressure, "Delanium" high-density graphite discs will still fail within the ±5% ASME burst tolerance!

Low-cost, replaceable discs are easily installed in re-usable carbon or aluminum holders. Ratings and sizes stamped on external "ears" are plainly visible, even when installed.

Immediate delivery from stock on standard sizes: 2" to 6"; burst pressure ratings 1 to 100 psig; operating temperatures to 650°F. Other sizes and ratings to order. Write for technical data and price schedule.

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For more information circle **95** on inquiry card.

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cutters

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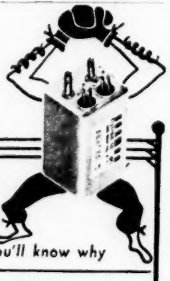
For more information circle **96** on inquiry card.

the leading contender in the sensitive relay class!



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MIGHTY SERIES "T"
Compare it and you'll know why

- ★ .975" x .975" x 1¾" high
- ★ Up to DPDT – 2 amp. 28V. DC, 115V AC
- ★ Sensitivity down to 6 milliwatts
- ★ Coil Resist. up to 20,000 ohms
- ★ Will meet MIL-R-5757C

The latest addition to a line of miniature hermetically sealed sensitive relays, the new Kurman Series "T", weighing only 3½ oz., is now available—the mighty midget of the sensitive class. Radically different in design, you will find the Series "T" to be superior in performance — economically priced with excellent delivery service.

Why not specify the Series "T" for your next sensitive relay application and check its performance for yourself? Write to Dept. I A for detailed specification sheet.

VISIT BOOTH 816—AUTOMATION SHOW

KURMAN ELECTRIC CO.
DIVISION OF NORBUTE CORP.
Quality Relays Since 1928
191 Newel Street, Brooklyn 22, New York

For more information circle **97** on inquiry card.

NEW INSTRUMENTS

last minute items

BOOSTER AMPLIFIER. New Knight KN-3061, for use with any conventional P-A amplifier, provides 60 watts of added power output with only 0.4 volt input.—Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill.

For more information circle **325** on inquiry card.

TERMINALS AND CONNECTORS. New Strato-Therm high-temperature heat-resistant units for aircraft and missile circuits feature vibration resistance. Wire sizes 22 through 10 AWG. —AMP Inc., Harrisburg 31, Pa.

For more information circle **326** on inquiry card.

WIDE-BAND AMPLIFIER. New Model WA-600 covers 6-60 Mc range without adjustments or change in IF strips; features exceptional performance under any conditions of pulsed operation.—Arenberg Ultrasonic Lab., Inc., 94 Green St., Jamaica Plain 30, Mass.

For more information circle **327** on inquiry card.

H & V CONTROL. New control package for electric heat classroom unit ventilators has positive-acting step control which obviates need of expensive variable-voltage regulators and magnetic contactors.—Barber-Colman Co., Rockford, Ill.

For more information circle **328** on inquiry card.

SMALL MOTOR. New 1/40-hp Type FSE-23 for intermittent-duty applications such as adding machines, actuators, etc., is series-wound, self-ventilated, has a nominal speed of 5000 rpm.—Bodine Electric Co., 2254 W. Ohio St., Chicago 12, Ill.

For more information circle **329** on inquiry card.

TRIMMING RESISTORS. New Model 200 Trimpots, replacing Models 120, 130 and 205, have power rating extended from 50°C to 70°C and total resistance range is now 50 instead of 25.—Bourns Laboratories, Inc., P. O. Box 2112, Riverside, Calif.

For more information circle **330** on inquiry card.

CONNECTOR-MOUNTED CHOPPER. New model of miniature hermetically-sealed Syncroverter Switch operates at extremes of altitude, temperature, shock, vibration, and acoustic noise encountered in airborne equipment. —The Bristol Co., Waterbury 20, Conn.

For more information circle **331** on inquiry card.

WATER-HEATER VALVES. New Type F-2T pressure-temperature valves for water heaters feature side-mounted fusible plugs easily replaced without removing or disconnecting valve, yet provide adequate temperature protection.—Cash-Acme, P. O. Box 191, Decatur, Ill.

For more information circle **332** on inquiry card.

DISPLACEMENT PICKUP. New Model 110 features carbon film resistance element, whence voltage output with virtually infinite resolution, typical

linearity of 0.05% for a 1" stroke.—Computer Instruments Corp., 92 Madison Ave., Hempstead, N. Y.

For more information circle **333** on inquiry card.

FREQUENCY COUNTERS. All new models of maker's counting, timing, and frequency-measuring equipment operate at 200-kc basic counting rate (formerly 100 kc).—Computer-Measurements-Corp., 5528 Vinel and, N. Hollywood, Calif.

For more information circle **334** on inquiry card.

SWITCHES. New heavy-duty slide switches, conservatively rated for 3-amp service at 125 vac, feature long service life; are available sp-st, sp-dt, dp-st and dp-dt.—The Wirt Co., 5221 Greene St., Philadelphia 44, Pa.

For more information circle **335** on inquiry card.

ITV. New automatic television camera is the world's smallest and also the first fully-transistorized; includes all technical features of broadcast equipment yet weighs about 4 lb (without optics).—Dage TV Div., Thompson Products, Inc., Michigan City, Ind.

For more information circle **336** on inquiry card.

VF OSCILLATOR. New Model 110-A self-contained lab frequency generator has continuously adjustable output of 100 cps to 100 kc; can be automatically programmed for 11- or 18-point calibration.—Digital Instrument Labs., 152 S. Atlantic Blvd., Los Angeles 22, Calif.

For more information circle **337** on inquiry card.

AMPLIFIER. New HF-32 hi-fi 30-watt integrated amplifier, available in kit and factory-wired forms, has 3 low-level inputs, NARTB tape head equalization, 3 high-level inputs.—EICO, 33-00 Northern Blvd., Long Island City 1, N. Y.

For more information circle **338** on inquiry card.

POWER SUPPLY KIT. New KPS-2 dual-purpose dc power supply kit is designed for servicing all transistor portable radios as well as 12-v auto radio receivers; has 0-75 milliammeter and 0-10 ammeter as well as 0-20 voltmeter.—Electro Products Labs., 4500 N. Ravenswood Ave., Chicago 40, Ill.

For more information circle **339** on inquiry card.

LOAD CELL. New special modification of maker's load cell, for tall tanks set on a small-diameter base, prevents tank from tipping if subjected to an accidental lateral load.—The A. H. Emery Co., Pine St., New Canaan, Conn.

For more information circle **340** on inquiry card.

DELAY LINES. New precision Balanced Audio Delay Lines, up to 8 milliseconds (longer delays by cascading), introduce constant delay over useful AF range of a standard telephone transmission cable.—Epsco Components, 108 Cummington St., Boston, Mass.

For more information circle **341** on inquiry card.

TAPE AMPLIFIER. New Minidrive transistorized airborne subminiature

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For more information circle **133** on inquiry card.

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by Allen L. Chaplin, 1950.
cloth, 4½" x 8", 144 pages .....Price **$2.00**

Operation and Care of Circular-Scale Instruments
by James Spencer, profusely illustrated with circuit diagrams, schematic diagrams, and photographs. 1949.
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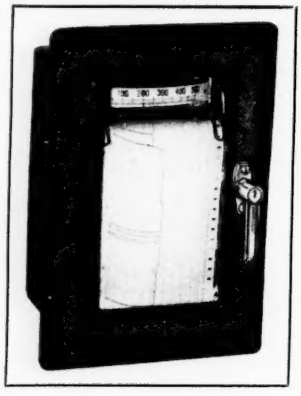

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For more information circle **98** on inquiry card.

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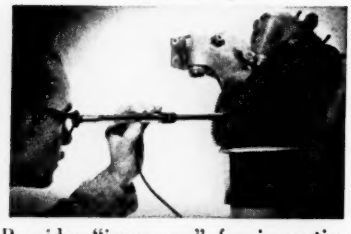

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For more information circle **100** on inquiry card.

NEW INSTRUMENTS

(14 lb) digital tape recording amplifier provides for 14 channels of pulse data recording on magnetic tape.—Epsco, Inc., 588 Commonwealth Ave., Boston 15, Mass.

For more information circle **342** on inquiry card.

HI-TEMP RELAY. New BHSM-HT 500-cps 10-G-vibration high-temperature (125°C) hermetically-sealed relay is available with contacts up to 4p-dt, 3 amp @ 32 vdc or 115 vac.—R-B-M Div., Essex Wire Corp., Logansport, Ind.

For more information circle **343** on inquiry card.

ACCELERATION PICKUP. New medium-G-range TA-200 and TA-300, for medium-frequency and high-frequency range respectively, have wire-wound or evaporated-film resistors, or ac type pickoffs.—Fairchild Controls Corp., 225 Park Ave., Hicksville, N. Y.

For more information circle **344** on inquiry card.

BUDGET-PRICE TV CAMERA. New TE-6-A small single-unit TV camera features resolution of better than 300 lines over line voltage changes from 100 to 130, crystal-controlled RF frequency, transistor L-C oscillator.—General Electric Co., Technical Products Dept., Syracuse, N. Y.

For more information circle **345** on inquiry card.

GLOW LAMP. New NE-81 pre-aged stabilized glow lamp for use as a circuit component will have many uses where close voltage control is essential.—GE Miniature Lamp Dept., Nela Park, Cleveland, Ohio.

For more information circle **346** on inquiry card.

TRANSISTOR CIRCUIT LAMP. New low-current (15 ma @ 10 v) GE344 incandescent lamp is for indicator use in transistorized circuits.—GE Miniature Lamp Dept., Nela Park, Cleveland 12, Ohio.

For more information circle **347** on inquiry card.

IGNITRON. New GL-7151 size E control ignitron tube for ac control service (resistance welding, etc.) has stainless steel jacket with built-in water channels; features bracket for detachable thermostat.—GE Power Tube Dept., Schenectady 5, N. Y.

For more information circle **348** on inquiry card.

CENTRIFUGAL BLOWERS. Four new miniature models of ac centrifugal blowers offer extremely high outputs (to 45 cfm) in small size units.—Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio.

For more information circle **349** on inquiry card.

AUTOMATIC TYPEWRITER TESTER. New Data-Line for data systems isolates and identifies operating malfunctions which manual low-speed testing will not reveal; positively determines faultiness of typewriter itself or of other system components.—Hanson-Gorrill-Brian, Inc., 85 Hazel St., Glen Cove, L. I., N. Y.

For more information circle **350** on inquiry card.

TRANSISTOR POWER SUPPLY. New 712A delivers 0-30 v continuously variable. Close regulation NL to FL (0.3% or 30 mv) and low ripple voltage (less than 130 uv) assure high accuracy of experimental results.—Hewlett-Packard Co., 275 Page Mill Rd., Palo Alto, Calif.

For more information circle **351** on inquiry card.

POWER OSCILLATOR. New Model 150 delivers 160 va with less than 1% distortion. Internal oscillator generates 400 cps ± 0.25% or variable frequency from 350 to 450 cps. Industrial Test Equipment Co., 55 E. 11th St., New York 3, N. Y.

For more information circle **352** on inquiry card.

MINIATURE TRANSFORMERS for transistor application include models for interstage, driver and output service; have unique design and assembly insuring maximum frequency response and power transfer.—James Vibrapowr Co., 4050 N. Rockwell St., Chicago 18, Ill.

For more information circle **353** on inquiry card.

TEMPERATURE CONTROL VALVES are now available in sizes ¼" to 2" with new plastic-coated sensing bulb and thermal system for use in plating tanks and other corrosive applications. Jordan Industrial Sales Div., OPW Corp., 6013 Wiehe Rd., Cincinnati 13, Ohio.

For more information circle **354** on inquiry card.

MAGNETOSTRICTIVE FERRITES. New Types N-50 and N-51 exhibit many desirable properties for microwave and other diversified applications. Finished pieces can be produced to 0.0005" tolerance without radial cracking.—Kearfott Co., Inc., Little Falls, N. J.

For more information circle **355** on inquiry card.

POWER SUPPLIES. New LT Series transistorized power supplies are rated for convection cooling (no internal blowers); deliver 0 to 32 vdc @ 0 to 2 amp. Input 105-125 vac, 50 to 400 cps.—Lambda Electronics Corp., College Point 56, N. Y.

For more information circle **356** on inquiry card.

TAPE DEMAGNETIZER. New large Model N-2, for broadcasting and data tapes, takes reels up to 10½" for tape widths up to 2".—Librascope, Inc., 40 E. Verdugo Ave., Burbank, Calif.

For more information circle **357** on inquiry card.

PORTABLE LATHE. New Master BWW is self-contained (no bench mounting needed), has 110-vac motor, 3" swing, 4½" between centers, speeds to 3000 rpm, shipping weight 12 lb.—MasterSon Engineering Co., P. O. Box 24016, Los Angeles 24, Calif.

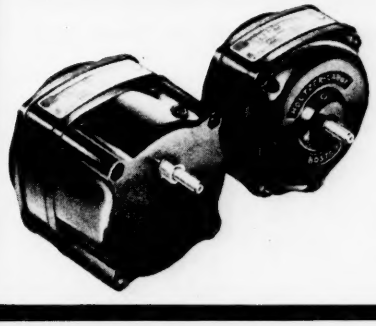
For more information circle **358** on inquiry card.

STEREOPHONIC CABINET. New M-90 recorder- reproducer, said to feature ultimate in recording and broadcasting field, has push-button controls, 15 and 7½ ips; automatic tape lifter;

New Designs in Motors from HOLTZER-CABOT

VARIABLE SPEED SUB-FRACTIONAL DC MOTOR

This new motor—Model RBD-25—is available in two standard units: RBD-2505 with a rating of 0.5 oz. inches; and RBD-2510, rating 01.0 oz. inches. Both operate at speeds up to 1800 RPM with input of 24 to 115 V. D. C. This is a shunt wound motor and speed can be varied by changing armature voltage.



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Model RBC-2514. Available with basic speeds of 1800 RPM and 3600 RPM and with standard gear reductions from 3:1 to 3600:1. Basic torque ratings for continuous duty at 115 volts, 60-cycles; 3600 RPM synchronous range from 0.15 to 0.5 oz. inches.

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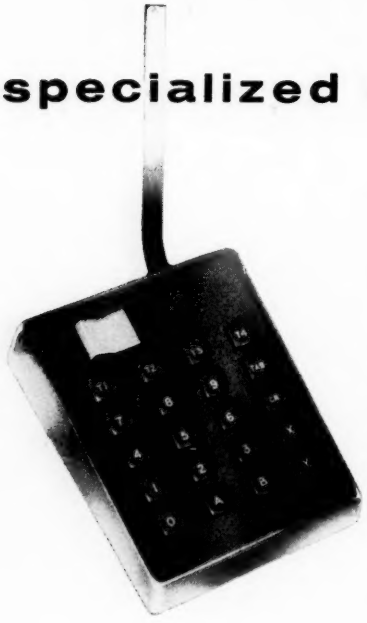

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For more information circle **107** on inquiry card.

NEW INSTRUMENTS

full remote control.—Magnecord Div., Midwestern Instruments, Tulsa, Okla.
For more information circle **359** on inquiry card.

POWER SOURCE FOR PORTABLE DEVICES. New Eveready Energizer 1½-volt leak-proof alkaline cell gives up to ten times longer service than a standard flashlight cell.—National Carbon Div., Union Carbide Corp., 30 E. 42nd St., New York 17, N. Y.
For more information circle **360** on inquiry card.

HIGH SPEED CLUTCH-BRAKE. New Exactuator clutches & brakes operate within one millisecond (5 to 10 times faster than conventional devices). Exclusive clutch design makes torque output linear with respect to voltage input.—Norman Hardy Associates, P. O. Box 97, Wyncote, Pa.
For more information circle **361** on inquiry card.

ELECTROMETER. New Model 6000 Dynacon is the first commercially available dynamic condenser electrometer to measure soft beta-emitting isotopes.—Nuclear-Chicago Corp., 229 W. Erie St., Chicago 10, Ill.
For more information circle **362** on inquiry card.

ALPHA AND BETA COUNTER. New PCC-10A converts any scaler into proportional counter for detecting and counting alpha and beta activity.—Nuclear Measurements Corp., 2460 N. Arlington Ave., Indianapolis 18, Ind.
For more information circle **363** on inquiry card.

LIGHTWEIGHT LIGHT DIMMERS. New variable-voltage power transformers are lighter and smaller than customary; calibration makes it possible to select a given light intensity in any cockpit or cabin.—Osborne Electronics Corp., 712 S. E. Hawthorne Blvd., Portland, Oregon.
For more information circle **364** on inquiry card.

PANEL LAQUER. New spray-on touch-up lacquer preserves appearance of maker's control panel-boards, comes in ASA 61 gray and #7 light green.—Panellit, Inc., 7401 N. Hamlin Ave., Skokie, Ill.
For more information circle **365** on inquiry card.

IMPROVED STAINLESS FITTING. New stainless steel bite-type tube fitting may satisfy demand for a "universal usage" fitting having both adequate corrosion resistance and high pressure capacity.—Parker-Hannifin Corp., 17325 Euclid Ave., Cleveland 12, Ohio.
For more information circle **366** on inquiry card.

SPEED REDUCERS. New Type DE worm & wheel speed reducers are available in even step ratios from 15:1 to 120:1 in shaft sizes of ⅛", 3/16", and ¼", in 48 and 64 pitches.—PIC Design Corp., 477 Atlantic Ave., E. Rockaway, L. I., N. Y.
For more information circle **367** on inquiry card.

MULTI-CONTACT RELAY. New continuous-duty KF Relay with common movable contact arms for switching many circuit elements can be adapted for up to 5p-dt or 7p-st; can be supplied to operate on ac or dc voltage.—Potter & Brumfield, Inc., Princeton, Ind.
For more information circle **368** on inquiry card.

RF POWER AMPLIFIER. New REL-09-HF miniature RF power amplifier (further development of REL-09) extends power amplification range from 235 to 245 Mc.—Rheem Electronics Div., 7777 Industry Ave., Rivera, Calif.
For more information circle **369** on inquiry card.

MISSILE-TEST H-V SLIP RING. New centrifuge slip ring has three high-voltage circuits capable of 10 kv dc continuous (tested at 20,000 v Hipot).—Slip Ring Co. of America, 3612 W. Jefferson Blvd., Los Angeles 16, Calif.
For more information circle **370** on inquiry card.

HIGH-CURRENT SUPPLY. New Model MA28-125 dc power supply can feed entire systems drawing up to 125 amp @ 18 to 36 vdc. Its capacity is 4000 watts of controlled power; yet rack-mounted unit requires only 21" of rack height.—Sorenson & Co., Inc., Richards Ave., S. Norwalk, Conn.
For more information circle **371** on inquiry card.

DUST-TIGHT VT's. New EN116, EN117, EN216 and EN217 Powerstat variable transformers feature a dust-tight enclosure in functional design for maximum user and unit protection.—The Superior Electric Co., Dept. EN, Bristol, Conn.
For more information circle **372** on inquiry card.

KLYSTRON. New VA-833A wide-tuning range four-cavity amplifier klystron, suitable for forward scatter communications and UHF TV, contains all rf circuitry required to boost 1-watt signal to 10 kw.—Varian Associates, Palo Alto, Calif.
For more information circle **373** on inquiry card.

BELLOWS-SEALED VALVE. New R-300-S right-angle 3" unit provides positive shutoff in high-vacuum systems; has exceptionally high conductance.—Veeco Vacuum Corp., 86-P Denton Ave., New Hyde Park, N. Y.
For more information circle **374** on inquiry card.

GEAR HEAD MOTOR. New miniaturized Model P5B827P75 withstands 7500-G shock; operates on 28.5 to 31.5 vdc; develops 1000 oz-in torque at −65°C; 13,840:1 ratio gives output shaft 1.3 rpm.—Western Gear Corp., P. O. Box 182, Lynwood, Calif.
For more information circle **375** on inquiry card.

VHF MULTICOUPLER can couple up to five receivers to one antenna with minimum interaction and loss in sensitivity. Range 90-200 Mc with maximum efficiency and 50-200 Mc with less.—RF Div., Westronics, Inc., 3605 McCart St., Fort Worth, Texas.
For more information circle **376** on inquiry card.

ITV ZOOMER LENS. New Mark II lens with three built-in motors weighs 2½ lb; has full zoom range of 6:1 and two focal length ranges, 22-130 mm and 35-210 mm.—Zoomer, Inc., Glen Cove, N. Y.
For more information circle **377** on inquiry card.

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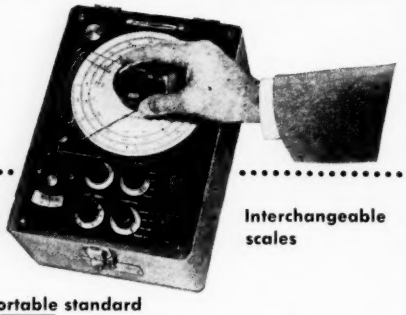

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For more information circle **106** on inquiry card.

new plants and mergers

GPS INSTRUMENT CO., analog computer manufacturer, has moved into a new building at 130 Needham St., Newton 64, Mass.

HAGAN CHEMICALS AND CONTROLS, Inc. has acquired the name and tangible assets of Kybernetes Corp. Kybernetes will function as part of the instruments and control division.

AMERICAN ELECTRONICS, INC. has been licensed to build and sell oil field automation systems under patents held by Shell Development, a subsidiary of Shell Oil Co.

PERKIN-ELMER CORP. announces formation of a new foreign subsidiary—Perkin-Elmer France, S.A.R.L., in Paris—which will handle sales and service of analytical instruments.

PYRAMID ELECTRIC CO. has moved its plant to Darlington, S. C., while sales and accounting departments, and jobber warehouse will remain in North Bergen, N. J.; the manufacturing operation in Gastonia, N. C. will continue as heretofore.

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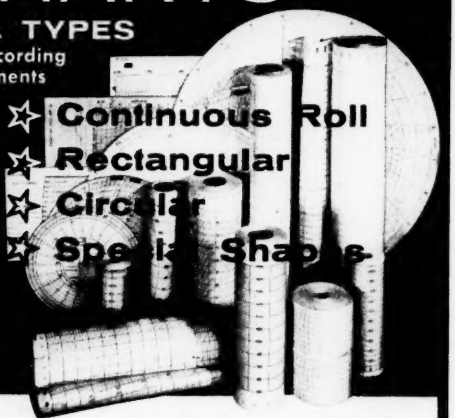

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people in the news

Martin Rubin

R. A. Lowe

S. G. Oppenheim

WAUGH ENGINEERING announces that *Martin Rubin* has joined the engineering staff as Senior Mechanical Engineer.

BALDWIN-LIMA-HAMILTON has appointed *Richard A. Lowe* Sales Manager for the SR-4 Products Group.

W. S. ROCKWELL CO. announces that *Stanley G. Oppenheim* has been named vice-president and general manager.

AUERBACH ELECTRONICS CORP. announces three major staff appointments: *Robert M. Schultz* and *John D. Harris* have been named to the Technical Staff; and *Nolan M. Goldberg* will be responsible for project control of all corporate projects as well as purchasing and accounting.

MID-CENTURY INSTRUMATIC CORP. announces appointment of *Jean H. Rooney* to manager of sales promotional activities.

COMAR'S NEW

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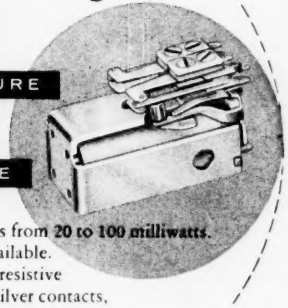
SENSITIVE



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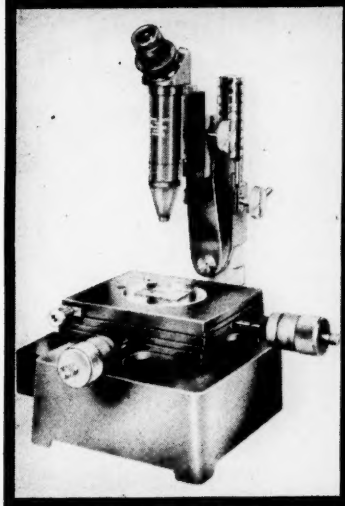
RELAYS
SOLENOIDS
COILS
SWITCHES
HERMETIC SEALING

Send for Bulletin TQ

For more information circle **108** on inquiry card.

Leitz New SIMPLEX TOOLMAKERS MICROSCOPE



YOU GET
A COMPLETE TOOLMAKER MICROSCOPE
of 2" x 2" range in .0001" at a basic price of $1150. Compare this outstanding value.

Request catalog 81/155

OPTO-METRIC TOOLS, INC.
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For more information circle **109** on inquiry card.

Petrometer
SERIES 1400
LIQUID DEPTH GAUGES

ACCURATE and EASY TO INSTALL

Available in 4 Models, Petrometer Series 1400 Tank Gauges operate on the sound principle of hydrostatic pressure. No moving parts, no expensive electrical or electronic equipment. Large vertical scale gives accurate, easy-to-see reading. And construction features make installation easy.

For complete information send for Bulletin 6004

Petrometer
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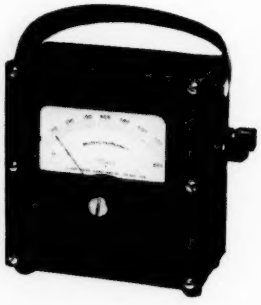
43-22 TENTH ST., LONG ISLAND CITY 1, N. Y.

For more information circle **110** on inquiry card.

Alnor®
PYROMETER
TYPE 1500



Checking temperatures of electric heating mantles is but one of the many laboratory temperature jobs performed with consistent accuracy within ¾ of 1% full scale—under all conditions.

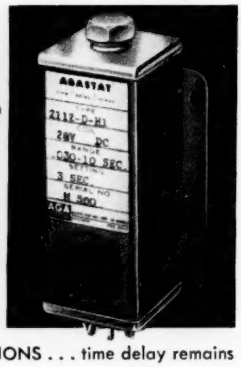
Sturdy case protects precision meter movement in portable use. Direct reading scale face can be quickly read at distance—no slide wires or conversion tables needed. Available in ten scale ranges from 0-400° to 0-3000° F. or centigrade equivalents.

Get full details on the Type 1500 in Bulletin 4434. Illinois Testing Laboratories, Inc., Room 518, 420 N. LaSalle St., Chicago 10, Ill.

Alnor PRECISION INSTRUMENTS FOR EVERY INDUSTRY

For more information circle **32** on inquiry card.

NEW MINIATURE AGASTAT® time delay relay



for missile, aircraft and electronic applications

INSTANTANEOUS RECYCLING . . . reset time—less than .020 seconds

UNAFFECTED BY VOLTAGE VARIATIONS . . . time delay remains constant from 18 to 30 volts DC

ADJUSTABLE . . . time delays from .030 to 120 seconds

CHOICE OF OPERATION . . . for either energizing or de-energizing

SMALL . . . height—4⅝" . . . width—1 13/16" . . . depth—1½"

LIGHT . . . maximum weight—15 ounces

MEETS ENVIRONMENTAL REQUIREMENTS OF MIL-E-5272A

This new AGASTAT time delay relay is an externally adjustable, double-pole, double-throw unit. It incorporates the basic AGASTAT timing principle, proved by a half-century of reliable operation on automatic aids to navigation, in a space-saving miniature unit built to withstand the rugged environmental conditions of missile and aircraft applications.

For specific information on the new AGASTAT relay for your application, write to Dept. A30-69.

AGA ELASTIC STOP NUT CORPORATION OF AMERICA
1027 Newark Avenue, Elizabeth, New Jersey
Pioneers in pneumatic timing

For more information circle **111** on inquiry card.

PEOPLE IN THE NEWS—CONTINUED

FAIRCHILD CONTROLS has appointed *Thomas F. D'Andrade* National Sales Manager for the Components Div.

NARDA ULTRASONICS has appointed *Paul W. Steen* Manager of Distributor Sales.

TECHNITROL ENGINEERING CO. and *L & O Research and Development Corp.* have announced plans to merge.

SERVOMECHANISMS, INC. elected *G. Q. Decker* a vice-president.

WEKSLER INSTRUMENTS announces appointment of *Nicholas C. Munisteri* as assistant to the vice-president in charge of sales.

GENERAL PRECISION EQUIPMENT'S president, *Edwin A. Link*, has been appointed to the executive committee of Flight Safety Foundation.

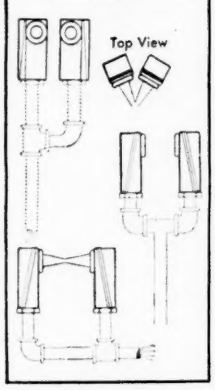
WAUGH ENGINEERING CO. has added *Martin Rubin* to its staff as senior mechanical engineer.

A. W. CASH VALVE MFG. CORP. has appointed *Ralph D. Hiser* sales manager of custom products for the Industrial Division.

PARTLOW CORP. announces appointment of *W. C. "Tony" Roberts* as advertising and publicity manager. He will also be in charge of sales promotion and market research.

MINNEAPOLIS-HONEYWELL's vice president *Henry F. Dever*, president of the Brown Instruments Div., has been appointed to the board of trustees of Drexel Institute of Technology.

Easy to Position EYES of AUTOMATION



Small Phototube and Light Source Heads in gasket sealed, cast aluminum cases. Screw onto 1/2" pipe or conduit for support, easy positioning and wiring.

Straight or fixed focus pin-point light beams. Available with normal, high speed, ultra sensitive and impulse actuated photoelectric controls; also photoelectric timing controls. Send for catalog.

AUTOTRON, INC.
3629 North Vermilion
BOX 72200 Danville, Ill.
Representatives in principal Cities

For more information circle **112** on inquiry card.

Charles A. Bengston

Charles A. Bengston, 84, chairman and treasurer of Chicago Apparatus Co. and a pioneer in the scientific equipment supply field, died May 12 in Tucson, Ariz.

John A. Obermaier

John A. Obermaier, 68, Founder and President of Illinois Testing Laboratories, Inc., died May 19, 1958, of a cerebral thrombosis. Mr. Obermaier started I.T.L. in 1914 and directed its growth. The trade name ALNOR (derived from the first halves of the names of his two sons, "Alfred" and "Norman") for scientific and industrial testing equipments is now known around the world.

Frank Berry Sanborn

Frank Berry Sanborn, Sc. D., Founder and Chairman of the Board of Sanborn Co., died in Cambridge, Mass., on May 16, at age 93. He was an engineer and author, as well as a professor of Civil Engineering at the Tufts Engineering School. He made numerous inventions in the fields of fluid flow, pressure measurement, and medical instrumentation.

STATHAM INSTRUMENTS has assigned new administrative responsibilities to the following four men: *Edmund Basich*, vice president for manufacturing; *Mario Di Giovanni*, vice president for engineering; *Gilbert N. Rosa*, vice president for marketing; and *Gordon Earl*, treasurer.

JEWELS *for* **INDUSTRY. . .**

By MOSER JEWEL COMPANY, pioneer industrial jewel manufacturer for over 50 years.

- HIGHLY POLISHED STEEL PIVOTS AND STAFFS
- HARD ALLOY WELDED TIPS
- NON-MAGNETIC STAFFS
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"Manufacturers of all types of Industrial Jewels"

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First choice of the rocket and missile industry...

Three superlative Marsh products are widely used and approved by the aircraft and missile industry:

MARSH Pressure Gauges... because they combine the most advanced features ever found in pressure, vacuum and compound gauges. There is a Marsh Gauge for every conceivable application.

MARSH Needle Throttling Valves... because they are guaranteed to give micrometer regulation at HIGH pressures—pressure up to 10,000 psi—and any temperature up to 500° F.

MARSH Dial Thermometers... because they offer the precision and accuracy a precision industry demands. Most complete line; wide temperature ranges, dial sizes, patterns, finishes.

All Marsh products available with AND threads

MARSH *New catalog covers all details*

MARSH INSTRUMENT CO. *Sales Affiliate of Jas. P. Marsh Corp.* Dept. 42, Skokie, Ill.
Marsh Instrument & Valve Co., (Canada) Ltd., 8407 103rd St., Edmonton, Alberta, Canada. Houston Branch Plant, 1121 Rothwell St., Sect. 15, Houston, Texas

For more information circle **113** on inquiry card.

INSPECTION BY AUTO-COLLIMATION

with the New **OPTO TOOLING AUTO-COLLIMATOR**

READING DIRECTLY TO ONE SECOND OF ARC... ...AND 5 MILLIONTHS OF AN INCH

NO MOVING PARTS
The light path is traced in this drawing. Dotted lines denote the path of the reflected rays from the mirror to a new position.

The OPTO Tooling Auto-Collimator is the ONLY way to accurately check the angular tolerance of parts and the squareness and perpendicularity relationship of surfaces to each other.

Here is

THE EQUIPMENT THAT DOES ALL THE HARD JOBS

- Testing surface flatness of machine beds
- Checking squareness of surfaces
- Measuring alignment of centers and squareness of axis to ways
- Testing angles on jigs and fixtures
- Checking straightness of bores
- Checking faces for parallelism
- Permanent accurate indexing
- Optical instrument assembly alignment

ECONOMICALLY PRICED — AS LOW AS . . . . . $586.00 for 15 sec. Model C140B

Send for Illustrated Folder — Code GIUKT

GEORGE SCHERR CO., Inc.
COMPLETE LINE OF PRECISION INSTRUMENTS
200-MG LAFAYETTE STREET • NEW YORK 12, N.Y.

For more information circle **115** on inquiry card.

MACHINE-DIVIDED SCALES

Made with latest SIP Swiss Automatic Dividing Machines

LINEAR

Accuracy to ±.5 microns (0.0002")

Any scale pattern—Any line width—Any material

CIRCULAR

Accuracy to ±.5 seconds

FINE MACHINE ENGRAVING

Scales, Dials, Drums, Rods, Panels

ACCURATELY ETCHED RETICLES

Made to any specified pattern and dimensions

PROMPT DELIVERY

on large or small quantities.

L. C. RENICK CO.

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Flow Visualization Instrumentation

Schlieren Systems

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Wind Tunnel Optics

Mountings & Piers

Packaged Systems

Catalog upon request

John Unertl Optical Co.

3551-3555 East Street

Pittsburgh 14, Penna.

For more information circle **117** on inquiry card.

new literature

AUTOMATION

AUTOMATIC CONTROLS. 24-page brochure titled "Everything's Under Control" covers company's history, describes its divisions and their products. Robertshaw-Fulton Controls Co., Richmond, Va.

Circle **378** on inquiry card.

DRILLING CONTROL. 17" x 22" broadside titled "Numerical Drilling Control Enables one Drill Press to do the Work of Five" describes Digimatic Control System.—Electronic Control Systems Div., Stromberg-Carlson Co., 2231 South Barrington Ave., Los Angeles 64, Calif.

Circle **379** on inquiry card.

REMOTE ACTUATION. 4-page brochure describes Controlex mechanical push-pull remote control comprising a blade moving between bearing balls and housed in a tube.—Controlex Corp. of Am., Westchester County Airport, White Plains, N. Y.

Circle **380** on inquiry card.

SPEED CONTROL. 8-page Booklet F-1952 describes twelve typical installations of controlled automatic variable speed systems.—U. S. Electrical Motors Inc., P. O. Box 2058, Los Angeles 54, Calif.

Circle **381** on inquiry card.

CRANE CONTROL. 20-page Bulletin 9100 is a complete catalog of dc crane control equipment and a manual on selection and application of dc crane control.—The Clark Controller Co., 1146 E. 152nd St., Cleveland 2, Ohio.

Circle **382** on inquiry card.

VALVES

VALVES FOR NUCLEAR REACTORS. 4-page brochure covers solenoid valves for primary and secondary systems in pressurized-water reactors.—Automatic Switch Co., Florham Park, N. J.

Circle **383** on inquiry card.

RELIEF VALVES. Catalog Sections, 2 pages each, cover temperature relief valves, pressure relief valves, safety devices, etc.—A. W. Cash Valve Mfg. Corp., Wabash and Morgan, Decatur, Ill.

Circle **384** on inquiry card.

PRESSURE REGULATORS. 28-page Bulletin 401 shows how to select them by application requirements, includes graphic tables for rapid comparisons of basic regulator characteristics.—Kieley & Mueller, Inc., 64 Genung St., Middletown, N. Y.

Circle **385** on inquiry card.

CONTROL VALVE. Announcement describes Fig. 235-1 adjustable-cam lever-operated control valve designed to maintain a specific flow ratio between two variables.—Atlas Valve Co., 280 South St., Newark 5, N. J.

Circle **386** on inquiry card.

TEMPERATURE

THERMOMETERS. 60-page Catalog C-60-2 describes complete line of rectangular-case filled-system thermometers: indicators, recorders, transmitters, and electric or pneumatic control instruments. Industrial Div., Minneapolis-Honeywell Regulator Co., Wayne & Windrim Aves., Phila. 44, Pa.

Circle **387** on inquiry card.

MOTOR PROTECTORS. 4-page Bulletin PR-1243 answers fifteen questions about Klixon built-in 3-phase motor protectors.—Metals & Controls Corp., Spencer Thermostat Div., Attleboro, Mass.

Circle **388** on inquiry card.

THERMOSTAT. 4-page Technical Data Bulletin THSN-21 gives revised data on refrigeration and air-conditioning thermostat Klixon 20220 Series.—Metals & Controls Corp., Spencer Thermostat Div., Attleboro, Mass.

Circle **389** on inquiry card.

TEMPERATURE CONTROLS. 8-page Condensed Catalog 400 covers local-mounted remote-bulb, general-purpose, dual-switch, explosion-proof, indicating and non-indicating types.—United Electric Controls Co., 85 School St., Watertown 72, Mass.

Circle **390** on inquiry card.

VENTILATION CONTROL. 2-page Data Sheet F-8705 describes control package for electric heat classroom Unit Ventilators.—Barber-Colman Co., 1300 Rock St., Rockford, Ill.

Circle **391** on inquiry card.

TEMPERATURE CONTROLLERS. 4-page Catalog G-22 covers a complete line of differential-expansion temperature control instruments.—Burling Instrument Co., Inc., Chatham, N. J.

Circle **392** on inquiry card.

TEMPERATURE CONTROLLERS. 4-page Catalog MC-156 covers nine different types of differential-expansion temperature controllers.—Fenwal Inc., Leland St., Ashland, Mass.

Circle **393** on inquiry card.

CONNECTORS. 4-page bulletin describes new line of special high-temperature thermocouple receptacles and connectors.—Airflow Instrument Co., Glastonbury, Conn.

Circle **394** on inquiry card.

FLOW, PUMPS

ROTAMETERS. 8-page Bulletin 130 describes armored AR-MET rotameters designed for pressures up to 5000 psi and for flow rate equivalents up to 3000 gpm of water; includes

guide to selection of transmitting as well as point-of-measurement extensions.—Brooks Rotameter Co., P. O. Box 432, Lansdale, Penna.

Circle **395** on inquiry card.

STARCH COOKING. Data Sheet F-57-2 describes and illustrates Corn Products Sales Co.'s system, how controlled-volume pumps are used in the system to provide savings and high-quality cooked starch.—Milton Roy Co., 1300 E. Mermaid Lane, Phila. 18, Pa.

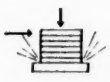
Circle **396** on inquiry card.

FLOW VISUALIZER. 4-page brochure contains first descriptive data on a new scientific instrument, the Visu-Flo Console.—Design Engineers, 214 South Church St., Rockford, Ill.

Circle **397** on inquiry card.

FLOW SWITCHES. 4-page bulletin describes vane or paddle type Peeco flow-actuated switches.—Power Engineering & Equipment Co., Inc., 1826 W. 213th St., Torrance, Calif.

Circle **398** on inquiry card.



PRESSURE, WEIGHT, FORCE

PRESSURE PICKUPS. Six two-page bulletins: Bulletin 1540D on Type 4-312A for 0-150 psia, psid, or psig; 1553C on Type 4-314A for 1000 to 5000 psi; 1568B on Type 4-316A for continuous operation to 600°F; 1579 on Types 4-320 and 4-321 for 7.5 to 50 psid or psig; 1604 on Type 4-380 two-pot pick-ups for missile applications; and 1606 on Type 4-322 for ± 50 psid.—Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.

Circle **399** on inquiry card.

MECHANICAL FORCE GAGES. 6-page folder describing complete line of mechanical force gages comprises 23 action photographs and complete specs.—W. C. Dillon & Co., Inc., 14620 Keswick St., Van Nuys, Calif.

Circle **400** on inquiry card.

WEIGHING. 6-page Bulletin 0557 describes Select-O-Weigh system of electrical controls which directly operate—in proper sequence—the gates and other equipment used in proportioning or mixing materials going to make up a finished product—in either continuous or batch processing.—Richardson Scale Co., Clifton, N. J.

Circle **401** on inquiry card.

TEST GAGES. 4-page Bulletin M-28 describes Martin-Decker precision test gages with 0.15% full-scale guaranteed calibration accuracy.—Decker Engineering Corp., 7706 Melrose Ave., Los Angeles 46, Calif.

Circle **402** on inquiry card.

PRESSURE GAGES. 48-page Catalog covers gages with ranges from vacuum to 20,000 psi plus complete engineering data and selection tables for

New COX Flow Indicator

2% Accuracy

Type 7A

The Cox Flow Indicator provides a dramatic new dimension in direct reading instrumentation. Where accuracy and reliability are essential *at a low initial cost*, the Type 7 is the answer.

The Indicator is for use with Cox turbine flowmeters or other transducers producing a frequency signal directly proportional to flow rate. It is available for readout in either volumetric or gravimetric units—with specific gravity adjustment. A span adjustment enables the Indicator to be calibrated to any particular transducer. Panel and portable models are available.

A second model not shown, the Type 7B, provides accuracy of 1% of flow.

We welcome the opportunity to demonstrate the Type 7 Indicator to you, without cost or obligation, to prove its superior features. *Cox Instruments Division, George L. Nankervis Company, 15200 Fullerton Avenue, Detroit 27, Michigan.*

A new bulletin describing the Type 7 Indicator is available. Ask for Bulletin No. 700

Cox Instruments

Precision Instruments Since 1912

For more information circle **118** on inquiry card.

NEW LITERATURE

applications in processing plant and power instrumentation.—Kunkle Valve Co., 120 South Clinton, Fort Wayne, Ind.

Circle **403** on inquiry card.

VACUUM GAGES. 2-page Data Sheet 561 describes measurements of high vacuum on production systems with laboratory accuracy by means of maker's McLeod-type vacuum gages.—Vacuum Equipment Div., F. J. Stokes Corp., 5500 Tabor Rd., Phila. 20, Pa.

Circle **404** on inquiry card.

HUMIDITY, WATER

HUMIDITY CONTROL. 4-page Bulletin covers Constant Temperature and Humidity Control Unit for testing labs; also apparatus for heating, cooling, dehumidifying, and circulating air into lab.—J. O. Ross Engineering Div., Midland-Ross Corp., 444 Madison Ave., New York, N. Y.

Circle **405** on inquiry card.

WATER TREATMENT EQUIPMENT. 12-page Bulletin 4433 lists water impurities and methods of treatment, illustrates typical treatment systems and describes equipment.—The Permutit Co., 50 West 44th St., New York 36, N. Y.

Circle **406** on inquiry card.

FILTRATION. 4-page bulletin describes operating principles and applications of Delpark Dual Manifold Filter-Matic Filter.—Industrial Filtration Co., Dept. DMB-469, Lebanon, Ind.

Circle **407** on inquiry card.

OPTICAL

OPTICAL INSTRUMENTS. 8-page first issue of quarterly "Optics Plus" covers giant missile tracking cameras and alignment devices for inertial guidance systems, sun-telescope camera for Project Stratoscope and projects for the IGY.—Engineering & Optical Div., Perkin-Elmer Corp., Norwalk, Conn.

Circle **408** on inquiry card.

ULTRASPEED CAMERA. 2-page Bulletin describes new Model UC-1 capable of one million frames per second.—Dynamic Measurements Corp., 40 So. Los Robles Ave., P. O. Box 4067, Pasadena, Calif.

Circle **409** on inquiry card.

SCALE READERS. 6-page Folder describes "Scan-A-Scales"—optical attachments which provide longitudinal, crosswise, or vertical settings to ten thousandths of an inch.—F. T. Griswold Mfg. Co., 315 W. Lancaster Ave., Wayne, Penna.

Circle **410** on inquiry card.

OPTICAL VERNIER. 4-page Bulletin 8091 describes new Vernac direct-reading optical vernier, which, mounted on a machine tool can be read directly to 0.0001" without interpolation.—Simpson Optical Manufacturing Co., 3200 W. Carroll Ave., Chicago 24, Ill.

Circle **411** on inquiry card.

PROFESSIONAL CAMERAS. 8-page bulletin introduces new Princeton enlarging-and-reducing camera—2-page bulletin describes Princeton Repro-Graphic camera.—Burke & James, Inc., 321 So. Wabash Ave., Chicago 4, Ill.

Circle **412** on inquiry card.

ANALYTICAL, LABORATORY

OXYGEN INDICATOR. 4-page Bulletin 0817-1 describes features and performance of new Portable Oxygen Indicator.—Mine Safety Appliance Co., 201 N. Braddock Ave., Pittsburgh 8, Pa.

Circle **413** on inquiry card.

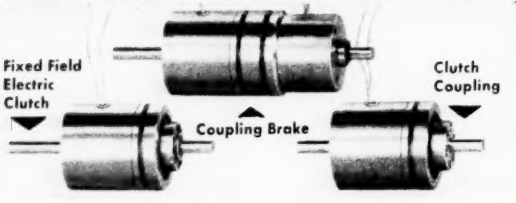
ABSORPTION CELLS. 12-page Bulletin 729 catalogs absorption cells and other sample handling accessories for Beckman B, DU, DK-1, and DK-2 Spectrophotometers.—Beckman/Scientific Instruments Div., Fullerton, Calif.

Circle **414** on inquiry card.

Introducing . . .

Simplatrol

FIXED FIELD Electric Clutches



In Miniature and Small Sizes

Super compact for use in instruments or assemblies where space is at a premium and performance requirements are high.

Three styles of Simplatrol Fixed Field Clutches ranging from 7/8" to 3 1/8" diameter. Torque output ranges from 10 oz. inches to 100 lb. inches.

Simplatrol Diaphragm Makes The Difference!

The only functional moving part in actuation of Simplatrol Fixed Field Clutches.

When current is applied to magnet, the diaphragm yields as the armature is attracted to the rotor body. Engagement is extremely rapid, smooth and silent.

The Simplatrol principle has been proved by years of use and features a minimum of parts to maintain or replace.

Ask for literature and recommendations on Simplatrol Fixed Field Miniature and Small Electric Clutches and Brakes.

Simplatrol products corp.

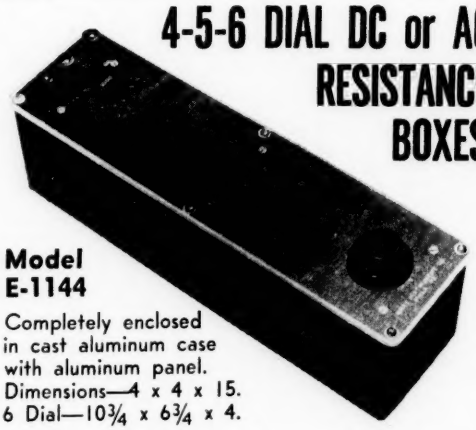
24-8 SALISBURY ST., WORCESTER, MASS.

Representation in Key Industrial Areas

738-7

For more information circle **119** on inquiry card.

4-5-6 DIAL DC or AC RESISTANCE BOXES



Model E-1144

Completely enclosed in cast aluminum case with aluminum panel.
Dimensions—4 x 4 x 15.
6 Dial—10¾ x 6¾ x 4.

- 3 Universal Binding Posts . . . one for ground connection
- Various Ranges. Each decade gives 10 steps plus zero position. Positive Detent Action
- Zero Resistance—0.0025 ohms per decade
- Accuracy above 0.1 ohm .05%, on 0.1 ohm, 0.1% maintained well above audio frequency range. Low temperature coefficient of resistance.

Send for our catalog of precision standard resistors, resistance bridges, and potentiometers

GRAY INSTRUMENT COMPANY

PHILADELPHIA 44, PA.

For more information circle **120** on inquiry card.

GAS ANALYZER. 4-page Bulletin TC-4012 describes Thermal Conductivity Gas Analyzer which measures concentration of one gas component in a mixture of gases.—Beckman/Process Instruments Div., Fullerton, Calif.

Circle **415** on inquiry card.

CONDUCTIVITY CONTROLLER. 2-page Data Sheet ND 47-95(1) describes Electromax Signalling Controller for use with electrolytic conductivity cells.—Leeds & Northrup Co., 4907 Stenton Ave., Phila. 44, Pa.

Circle **416** on inquiry card.

LAB APPARATUS. 16-page Issue 1-58 of Will "LabLog" describes recent developments including Thermistor Telethermometers, Chromatofuges, new mechanical high-vacuum pump, single-pan Becker balance with 2 beams, a new 3000° box furnace, B & L Student Microscopes, etc.—Will Corp., P. O. Box 1050, Rochester 3, N. Y.

Circle **417** on inquiry card.

FRACTOMETER. 12-page brochure describes Model 184 process vapor fractometer for multi-component analysis of gases and light liquids.—Perkin-Elmer Corp., Main Ave., Norwalk, Conn.

Circle **418** on inquiry card.

SPECTROPHOTOMETERS. 6-page bulletin describes Junior Spectrophotometer, offered in 3 models and with a choice of 4 power supply arrangements; also gives details on maker's cuvettes and cuvette adapters.—Coleman Instruments, Inc., 318 W. Madison St., Maywood, Ill.

Circle **419** on inquiry card.

PHOTOMETER. 6-page Bulletin 2295 describes Aminco Absolute Light-Scattering Photometer, measuring turbidity, dissymmetry, depolarization and angular scattering.—American Instrument Co., 8030 Georgia Ave., Silver Spring, Md.

Circle **420** on inquiry card.

HEATING JACKETS. 8-page Catalog 58 describes new line of Briskeat heating jackets and heating tapes.—Burrell Corp., 2223 Fifth Ave., Pittsburgh 19, Pa.

Circle **421** on inquiry card.

VACUUM SPECTROMETER. 4-page bulletin describes Quantovac, a fully-automatic quantometer designed primarily for iron and steel industry which will yield over 1000 determinations in continuous 8-hour operation.—Applied Research Labs., 3717 Park Place, Glendale 8, Calif.

Circle **422** on inquiry card.

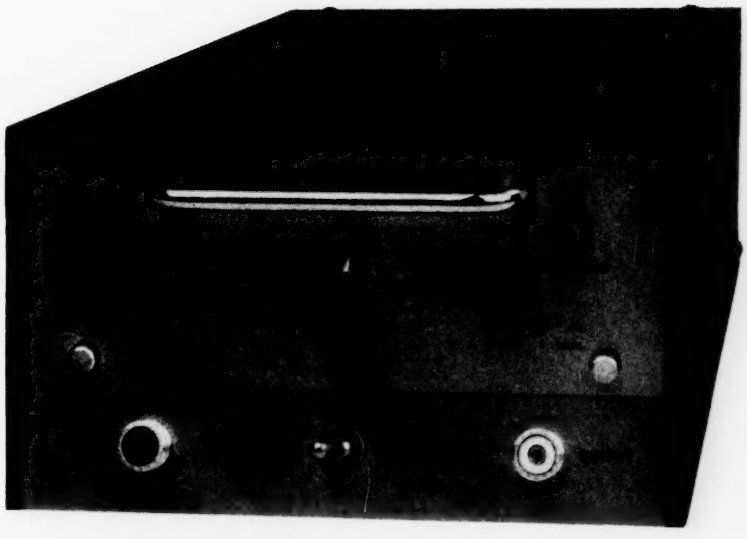
GLASS APPARATUS. 2-page Bulletin A 101 describes facilities for producing (1) hand-blown precision apparatus, (2) semi-mechanically produced equipment.—L. G. Nester Co., Inc., Millville, N. J.

Circle **423** on inquiry card.

BURETTES. Pocket folder describes Doerr Automatic Burettes and Wintrobe Hematocrit Tubes.—Doerr Glass Co., Vineland, N. J.

Circle **424** on inquiry card.

The amplifier
you have been waiting for...



EPSCO DA-102

WIDE-BAND DIFFERENTIAL

LOW-LEVEL DC AMPLIFIER

Designed for applications involving either dynamic or quasi-static data, the Epsco DA-102 is a wide-band, chopper-stabilized, differential DC Amplifier with very high open-loop gain. The differential input isolates the signal source, minimizing errors due to stray ground currents, hum and pick-up.

Compare these specifications:

6.5μ volts noise at 10 KC • 200,000 to 1 DC common mode rejection • up to 50,000 to 1 AC common mode rejection • less than 2μ volts per day short term drift • 3 db response at 20 KC for a gain of 1000 • 0.1% stability • ±20 volts DC single-ended output • up to 40 ma output current • 0, 100, 200, 500, 1000, 2000 gain settings

Complete specifications on request. Portable and rack mounting models available *now* for immediate delivery.

EPSCO SYSTEM BUILDING BLOCKS

- low-level differential amplifiers
- high-speed electronic multiplexers
- quick-look oscillograph recorders
- voltage-digital converters
- magnetic core buffer storage units
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For more information circle **121** on inquiry card.

NEW LITERATURE

MICRO LABWARE. 24-page catalog illustrates and prices micro and semi-micro apparatus and glassware.—Micro-Ware, Inc., Vineland, N. J.
Circle **425** on inquiry card.

DATA HANDLING

OSCILLOGRAPH MAGAZINE. 4-page Datarite Magazine Catalog No. 5-036 describes new rapid-access magazine which attaches directly to any Type 5-119 to provide developed and dried photographic oscillograph records concurrent with recording operation.—Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.
Circle **426** on inquiry card.

COMMUTATOR. 6-page bulletin describes Type 40-101 Plexicoder which commutates signals from up to 90 transducers at 112.5 samples per second and converts them into duration-modulated pulses.—Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.
Circle **427** on inquiry card.

ANALYTICAL COMPUTER. 2-page System Design Bulletin ES-002 describes Petrochemical Data Acquisition System.—Epsco Systems, a Div. of Epsco, Inc., 588 Commonwealth Ave., Boston 15, Mass.
Circle **428** on inquiry card.

POSITION INDICATORS. 2-page Bulletin 317 describes continuously-indicating digital position systems.—Datex Div., G. M. Giannini & Co., Inc., 1307 S. Myrtle Ave., Monrovia, Calif.
Circle **429** on inquiry card.

GEARED ENCODER SYSTEMS. 4-page Bulletin No. 316 describes the principles used in geared encoder systems to obtain high position output.—Datex Div., G. M. Giannini & Co., Inc., 1307 S. Myrtle Ave., Monrovia, Calif.
Circle **430** on inquiry card.

DATA PLOTTERS. 8-page brochure gives condensed specs of Model 314 Visual Recorder which plots 12 variables at 50 points per second.—Tally Register Corp., Seattle, Wash.
Circle **431** on inquiry card.

ANALOG COMPUTER. 8-page Brochure 393 describes new Model MC-400 Desk-Side Analog Computer, gives details of operational amplifiers and other standard and optional equipment, describes applications including solutions of longitudinal airframe equations with pitch damper.—Mid-Century Instrumatic Corp., 611 Broadway, New York 12, N. Y.
Circle **432** on inquiry card.

DIGITAL DISPLAYS. Bulletin 175-2 describes 4- and 5-digit DC Switch Modules which provide visual readout and contact closures for operating machine output equipment.—Electro Instruments, Inc., 3794 Rosecrans St., San Diego, Calif.
Circle **433** on inquiry card.

ANALOG COMPUTER MODULES. 4-page bulletin describes Model HKR Operational Manifold.—George A. Philbrick Researches, Inc., 230 Congress St., Boston 10, Mass.
Circle **434** on inquiry card.

ANALOG COMPUTER COMPONENTS. 4-page reprint of RSI paper, "New Integrating Circuit and Electronic Analog for Transient Diffusion and Flow" by J. Ross MacDonald.—George A. Philbrick Researches, Inc. 230 Congress St., Boston 10, Mass.
Circle **435** on inquiry card.

RECORDERS

OSCILLOGRAPH. 8-page Bulletin 1589 describes Type 5-140 Cathode-Ray Recording system which combines cathode-ray tubes with a precision optical system to provide continuous, high-resolution oscillograph records on standard film or paper.—Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.
Circle **436** on inquiry card.

OSCILLOGRAPHY. 4-page bulletin describes Model 1012 36-channel direct-recording Visicorder.—Heiland Div., Minneapolis-Honeywell, 5200 East Evans Ave., Denver 22, Colo.
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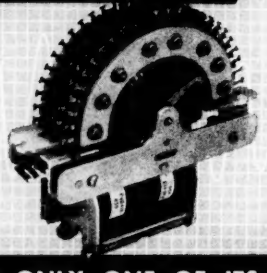

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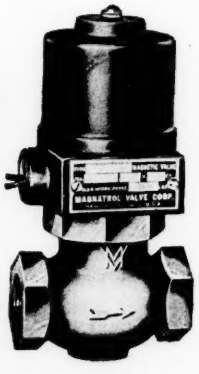

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RECORDERS. Folder describes (1) Model 201 Plotter which plots up to 8 points per second with 4 symbols or up to 20 per second with random symbols; (2) Visual Recorder which plots 12 selected flight-test variables.—Tally Register Corp., 5300 14th Ave., N.W., Seattle 7, Wash.

Circle **438** on inquiry card.

RECORDERS. 16-page Vol. 2, No. 1 of "The Brush Recorder" includes eight articles—on preventing bolt failures, reducing transformer noise, etc.—Brush Instruments, Div. of Clevite Corp., 3405 Perkins Ave., Cleveland 14, Ohio

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SHIPPING SHOCK RECORDER. Announcement of DMC Model SR-1 which is simply attached inside shipping case.—Dynamic Measurements Corp., 40 So. Los Robles Ave., Pasadena, Calif.

Circle **440** on inquiry card.

MONITORS

BEARING-OVERHEAT WARNING. 2-page bulletin describes Temperature Acceleration Indicator which gives alarm allowing machine to be shut down before bearing failure.—Lycoming Div. of Avco Mfg. Corp., Stratford, Conn.

Circle **441** on inquiry card.

ALARM SIGNAL CONSOLES. 4-page Form 11A covers line-protection systems, control panels, code units, emergency signal receivers, etc.—Notifier Corp., 239 South 11th St., Lincoln, Neb.

Circle **442** on inquiry card.

ALARM AND SCANNING SYSTEM. 4-page bulletin describes Monitron I & II for gathering alarm and control data from remote stations to a central station over wire or radio for visual and aural presentation.—Moore Associates, 2800 Spring St., Redwood City, Calif.

Circle **443** on inquiry card.

TESTING, GAGING

AMPLIFIER TESTER. 2-page Technical Data Sheet 118 describes REAC A400-1 dc amplifier tester.—Reeves Instrument Corp., 215 E 91st St., New York 28, N. Y.

Circle **444** on inquiry card.

AIR GAGING. 32-page Engineering Manual describes where and how to use Plunjet air gaging cartridges in single and multiple dimension gages and inspection fixtures.—The Sheffield Corp., Box 8931 Dayton 1, Ohio

Circle **445** on inquiry card.

SPRING TESTERS. 4-page bulletin describes new MST-Series testers which make use of push-pull dynamometer principle and hence are capable of testing both compression and extension springs.—John Chatillion & Sons, 85 Cliff St., New York, N. Y.

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HEISE GAUGES

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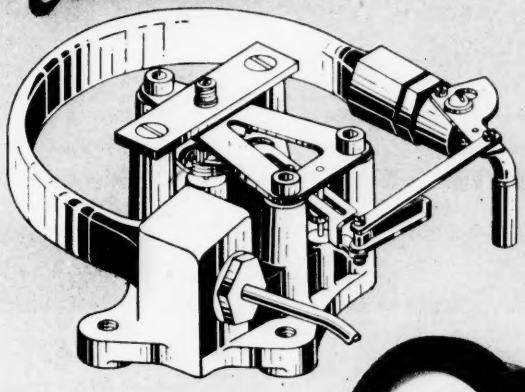

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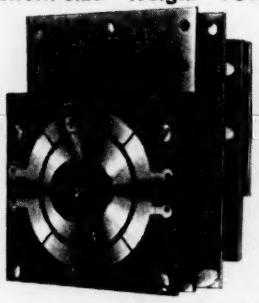

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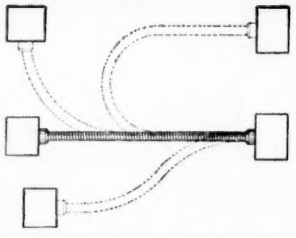

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For more information circle **127** on inquiry card.

NEW LITERATURE

MAGNETIC CORE TESTER. 4-page Bulletin 57-G describes Model 1100 Magnetic Core Tester, explains programming method, gives complete specs.—Rese Engineering, Inc., 731 Arch St., Phila. 6, Pa.

Circle **447** on inquiry card.

CALIBRATOR PANELS. 2-page bulletin describes H-58 Series Potentiometer Transducer Calibrator Panels.—Decker Engineering Corp., 7706 Melrose Ave., Los Angeles 46, Calif.

Circle **448** on inquiry card.

HYDRAULIC FLUID TESTING. Announcement of hydraulic fluid testing device for evaluation of fluids under fixed conditions of pressure and time.—Research Appliance Co., Route 8 at Craighead Rd., Box 307, Allison Park, Penna.

Circle **449** on inquiry card.

RELAY TESTER. 2-page bulletin describes new Model 140 Universal Relay Analyzer which measures pull-in and drop-out voltages, contact make and break times, overlap times, contact bounce, contact resistance under load and dry current, etc.—Schmeling Electronics, 20 First St., Keyport, N. J.

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STRESS-STRAIN ANALYSES. Two new--product announcements on (1) SM-3 Dynamic Stress Meter featuring elimination of contacting devices and suitable for dynamic strains to 14,000 cycles per second; (2) TR-400 FM Receiver with self-contained mercury battery.—Savage Instrument Co., 3131 N. 29th Ave., Phoenix, Ariz.

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TUBING, FITTINGS

HOSE FITTINGS. 8-page Catalog 4420 describes Hoze-lok-20 full flow fittings and hose for medium-pressure service.—Parker-Hannifin Corp., 173-25 Euclid Ave., Cleveland 12, Ohio

Circle **452** on inquiry card.

TRANSPARENT PLASTIC TUBING. 8-page catalog contains six tables of technical information on recommended uses, specs, etc.—Cobon Plastics Corp., 44 Lafayette St., Newark 2, N. J.

Circle **453** on inquiry card.

ELECTRICAL, ELECTRONIC INSTRUMENTS

COMPUTING GALVANOMETER. Bulletin 1605 describes Computing Galvanometer Type 7-370 for measuring low-level power in electronic equipment, ideal for recording instantaneous watts and its phase sensitivity enables user to determine power factor.—Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.

Circle **454** on inquiry card.

GALVANOMETERS. 12-page Bulletin 1528A and 2-page Bulletin 1603 cover Type 7-300 High-Performance Galvanometers, both fluid-damped and electromagnetically damped types.—Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.

Circle **455** on inquiry card.

CURRENT PULSE GENERATOR. 2-page Bulletin 57-C describes Model 1050 high-frequency (up to 500 kc) current pulse generator capable of high current outputs (up to 3 amp).—Rese Engineering, Inc., 731 Arch St., Phila. 6, Pa.

Circle **456** on inquiry card.

ELECTRICAL MEASUREMENTS. 2-page bulletin describes REL 500 Precision Universal Meter, essentially an ultra high impedance VTVM.—Rheem Mfg. Co., Electronics Div., 7777 Industry Ave., Rivera, Calif.

Circle **457** on inquiry card.

ELECTRONIC INSTRUMENTS. 4-page brochure covers phase meters and standards, vacuum-tube voltmeters, testers, Z-Angle Meters and Oscillographs.—Action Laboratories, Inc., 533 Main St., Acton, Mass.

Circle **458** on inquiry card.

ROTARY CONVERTERS. 8-page Engineering Catalog 2541 describes all models now in production.—Sangamo Electric Co. Springfield, Ill.

Circle **459** on inquiry card.

ELECTRICAL INSTRUMENTATION. 12-page ESI Condensed Catalog A-26 covers bridges and accessories, voltage dividers, decade capacitors, decade resistors, etc.—Electro-Measurements, Inc., 7524 S. W. Macadam, Portland, Ore.

Circle **460** on inquiry card.

VARIABLE TRANSFORMERS. 100-page Bulletin P258G reference-manual type of catalog contains product information, engineering data, outline drawings, connections, ratings, charts and illustrations on all standard 50/60-cps Powerstats plus some special use types.— The Superior Electric Co., Dept. P258G, 83 Laurel St., Bristol, Conn.

Circle **461** on inquiry card.

VARIABLE TRANSFORMERS. 4-page bulletin describes Powerstat EN 116, EN 117, EN 216, and EN 217 Series.—The Superior Electric Co., 83 Laurel St., Bristol, Conn.

Circle **462** on inquiry card.

ELECTRONIC INSTRUMENTS. Three advance bulletins describe (1) Weditrol Numerically Controlled Positioning System, (2) Confluxer Constant-Charge device, (3) Model 612A programmed pulse generator.—Wang Laboratories, Inc., 37 Hurley St., Cambridge 41, Mass.

Circle **463** on inquiry card.

OSCILLATORS. 4-page Bulletin 814-A describes Series 814 microwave oscillators.—Laboratory for Electronics, Inc., 75 Pitts St., Boston 14, Mass.

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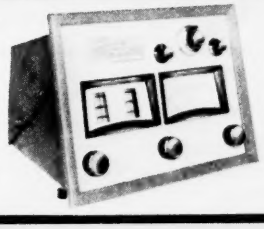

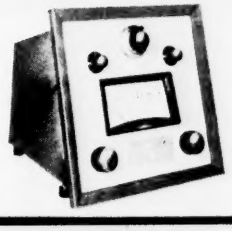

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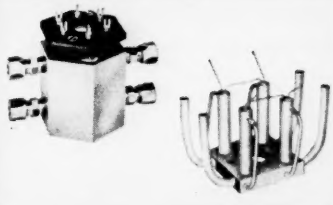

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ELECTRICAL INSTRUMENT. 2-page Engineering Data Sheet 297 describes new Model 173 1½"-300°-Scale Panel Meter with scale length comparable to that of conventional 4½" indicator.—International Instruments Inc., P.O. Box 2954, New Haven 15, Conn.
Circle **465** on inquiry card.

INDICATING INSTRUMENTS. 8-page Catalog 693-379 covers commercial, military, ruggedized, sealed, and special instruments.—Sun Electric Corp., Harlem & Avondale, Chicago 31, Ill.
Circle **466** on inquiry card.

VARIABLE FREQUENCY OSCILLATOR. 2-page bulletin describes Precision Model 110 self-contained laboratory standard.—Digital Instrument Labs., 152 S. Atlantic Blvd., Los Angeles 22, Calif.
Circle **467** on inquiry card.

MODULATION METER. 2-page Catalog No. MM-358 describes Amplitude Modulation Meter Model MM-120 (Commercial Equivalent of AN/USM-65).—Empire Devices Products Corp., Amsterdam, N. Y.
Circle **468** on inquiry card.

DC VOM. 4-page bulletin describes battery-powered Model 110 E-I-R Meter for measurement of dc voltage, current and resistance.—Belleville Hexem Corp., 638 University Ave., Los Gatos, Calif.
Circle **469** on inquiry card.

TUBES, TRANSISTORS

TRANSISTOR. 4-page technical bulletin describes Type 2N623 general-purpose p-n-p diffused-base germanium transistor.—Texas Instruments Inc., P. O. Box 312, Dallas, Tex.
Circle **470** on inquiry card.

SILICON DIODES. 24-page Catalog 58-S describes microwave silicon diodes; includes technical data and receiver design information for low-noise mixer and video diodes; also new diode for test equipment.—Microwave Associates, Inc., Burlington, Mass.
Circle **471** on inquiry card.

SILICON DIODES. 4-page Bulletin S-61 describes subminiature glass units of fast-recovery, high-conductance, and general-purpose types.—Semiconductor Div. Radio Receptor Co., Inc., 240 Wyeth Ave., Brooklyn 11, N. Y.
Circle **472** on inquiry card.

TUBE SHIELDS. 6-page Bulletin 100 details maker's tube shielding and tube guard products for miniature and sub-miniature electron tubes.—The Staver Co., Inc., 41-51 N. Saxon Ave., Bay Shore, N. Y.
Circle **473** on inquiry card.

HIGHEST-GRADE TUBES. 4-page interchangeability chart ETI-1572 lists essential characteristics of GE's 34

high-reliability "Five-Star" tubes and standard miniature prototypes which they can directly replace.—General Electric Co., Owensboro, Ky.

Circle **474** on inquiry card.

RECTIFIERS

RECTIFIERS. 40-page completely revised edition of Silicon Rectifier Handbook 67 bears a $1.00 price, but will be sent free to interested Instruments & Automation readers.—Rectifier Div., Sarkes Tarzian, Inc., 415 N. College Ave., Bloomington, Ind.

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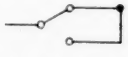
SELENIUM RECTIFIERS. 48-page Bulletin EPD 3116-1 describes new line of grain-oriented (TM) selenium rectifiers, employing rectifying crystals oriented for most effective rectification, hence more working rectifier crystals per sq. in.—Vickers Inc., Electric Products Div., 1815 Locust St., St. Louis 3, Mo.

Circle **476** on inquiry card.

RECTIFIERS. 2-page Bulletin SR 304 covers silicon power diodes; 2-page Bulletin SR-225 covers high-voltage silicon cartridge-type rectifiers.—International Rectifier Corp., 1521 E. Grant Ave., El Segundo, Calif.

Circle **477** on inquiry card.

SWITCHES, RELAYS



SWITCHES. 28-page Catalog 0158 covers precision snap-acting switch line, includes convenient pictorial index of dimension drawings, descriptions, force and movement spec tables, and electrical ratings.—Unimax Switch Div., The W. L. Maxson Corp., Ives Rd., Wallingford, Conn.

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SUBMINIATURE SWITCHES. 4-page bulletin covers line of precision snap-acting units in basic form and with a wide variety of actuators.—Unimax Switch Div., The W. L. Maxson Corp., Ives Rd., Wallingford, Conn.

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RELAYS. etc. 36-page Engineering Catalog 58 covers relays, solenoids, coils, etc.—Comar Electric Co., 3349 Addison St., Chicago 18, Ill.

Circle **480** on inquiry card.

MERCURY SWITCH. 2-page Data Sheet 144 describes a new Nylon-enclosed mercury switch, fabricated of materials which are highly resistant to effects of water, oil, alkalis, and acids.—Micro Switch, a Div. of Minneapolis-Honeywell Regulator Co., Freeport, Ill.

Circle **481** on inquiry card.

SWITCHES. 2-page Data Sheet 145 describes new "E6 and V6" housings, improvement in Micro Switch "E" and "V" type die-cast enclosed switches.—Micro Switch, a Div. of Minneapolis-Honeywell Regulator Co., Freeport, Ill.

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NEW LITERATURE

RELAYS. Binder-Type Revised Catalog contains a number of bulletins, some describing products, some giving engineering data.—Electronics Div., Iron Fireman Mfg. Co., 2838 Southeast Ninth Ave., Portland 2, Ore.

Circle **483** on inquiry card.

POWER SUPPLIES

POWER SUPPLY. 2-page technical data sheet covers Model 610B, a new 0-600 vdc, 0-1-amp regulated unit.—Sorensen & Co., Inc., Richards Ave., South Norwalk, Conn.

Circle **484** on inquiry card.

POWER SUPPLY. Bulletin 175-1 describes Transistorized Universal Power Module which supplies all power and reference voltages, switch drive for maker's other modules.—Electro Instruments, Inc., 3794 Rosecrans St., San Diego, Calif.

Circle **485** on inquiry card.

POWER SUPPLY APPLICATION. 4-page Bulletin 350 describes power supplies for lab, transistor, automation applications, etc.—Electronic Measurements Co., Inc., Engrg. Dept., Eatontown, N. J.

Circle **486** on inquiry card.

MAGNETICS

TRANSDUCTORS. 16-page Catalog T-10 covers the electronic industry's first standard line of transductors, designed for measurements of large amounts of direct current while electrically isolated from current-carrying conductor.—Control, a Div. of Magnetics, Inc., Butler, Penna.

Circle **487** on inquiry card.

MAGNETIC COMPONENTS. Binder contains nine bulletins or condensed catalogs on transformers, mag amps, reactors and filters.—Varo Mfg. Co., Inc., 2201 Walnut St., Garland, Tex.

Circle **488** on inquiry card.

ELECTRICAL, ELECTRONIC COMPONENTS

INSTRUMENT CHOPPERS. 4-page General Chopper Catalog tabulates complete technical specs for 60 different models, includes contact ratings, frequency, thermal and residual noise, etc.—James Vibrapowr Co., 4050 North Rockwell St., Chicago 18, Ill.

Circle **489** on inquiry card.

CAPACITORS. 18-page Catalog CRC-100 covers precision film capacitors in Mylar, Polystyrine, Teflon and Metallized Mylar.—Condenser Research Corp., Seymour, Ind.

Circle **490** on inquiry card.

DELAY LINES. 12-page booklet, "How to Use Delay Lines Efficiently," contains instructions for proper use and correct installation.—Columbia Technical Corp., 61-02 31st Ave., Woodside 77, N. Y.

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BINDING POSTS. 4-page Bulletin BP958 covers gold-plated 5-way binding post connectors in six colors, 30-

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amp current capacity and 1000-volt working voltage.—Superior Electric Co., Dept. BP, Bristol, Conn.

Circle **492** on inquiry card.

CAPACITORS. 4-page bulletin describes plastic film types, clear and metallized Mylar, Teflon and Bal-Film for temperatures to 200°C (392°F).—Balco Research Labs., Inc., Capacitor Div., 49-35 Edison Pl., Newark, N. J.

Circle **493** on inquiry card.

PRINTED CIRCUIT DESIGN DATA. 2-page Bulletin covers terminology and definitions, includes four helpful diagrams.—Electralab Inc., Industrial Center, Needham Heights 94, Mass.

Circle **494** on inquiry card.

STANDARD KNOBS. 8-page catalog of standard thermo-setting plastic knobs contains complete diagrams, dimensions and specs.—Waterbury Companies, Inc., P. O. Box 1032, Waterbury 20, Conn.

Circle **495** on inquiry card.

TERMINALS. 16-page catalog section covers terminals and connections for high-temperature applications.—AMP Inc., Harrisburg, Penna.

Circle **496** on inquiry card.

ELECTRONIC COMPONENTS. 4-page Bulletin MPE 2-58 and two 2-page bulletins describe TWT amplifiers, solenoids, TWT power supplies, etc.—Menlo Park Engineering, 721 Hamilton Ave., Menlo Park, Calif.

Circle **497** on inquiry card.

SEALS, TERMINALS. Binder contains eleven catalogs on compression seals, multiple headers, sealed terminals, condenser end seals, threaded seals, transistor closures, miniature closures, color coded terminals, etc.—Electrical Industries, 691 Central Ave., Murray Hill, N. J.

Circle **498** on inquiry card.

CAPACITORS. 2-page Bulletin EM-1 describes EM type and EMP type (printed circuit) dry electrolytic capacitors.—The Gudeman Co., 340 West Huron St., Chicago 10, Ill.

Circle **499** on inquiry card.

CAPACITORS. 4-page Catalog ME-1 describes ME type (twist prong) and MEP (printed circuit) dry electrolytic capacitors.—The Gudeman Co., 340 West Huron St., Chicago 10, Ill.

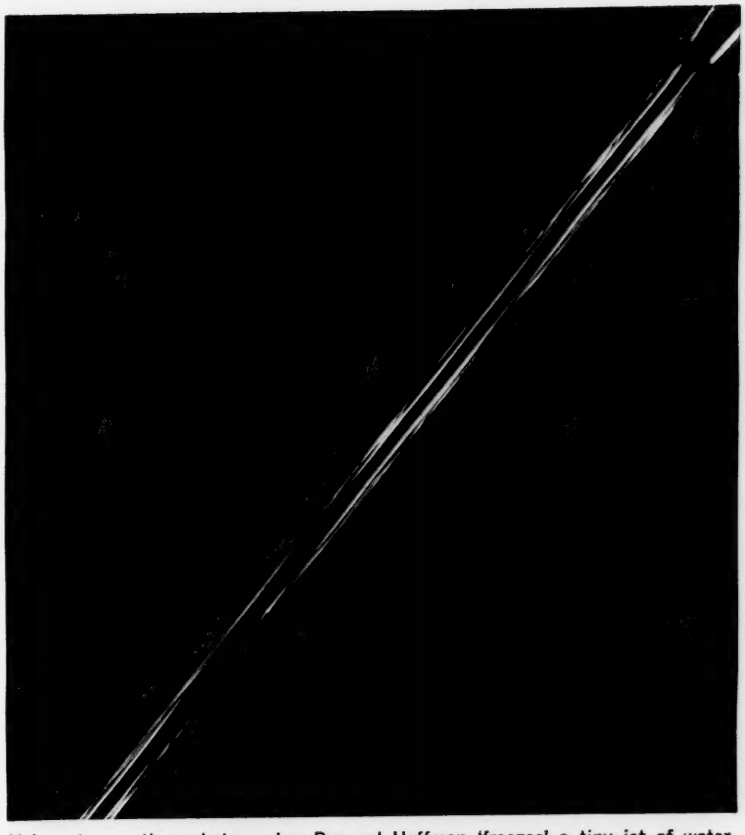
Circle **500** on inquiry card.

TERMINALS. 8-page catalog gives miniature standoffs, feed-thrus, plugs, jacks, and special terminal fabrications, insulated with TSI-type Teflon developed by maker.—Trinseel, Inc., Div. of Tri-Point Plastics, Inc., 177 I.U. Willets Rd., Albertson, L. I., N. Y.

Circle **501** on inquiry card.

SOLDERING TIPS. Catalog page No. 600 shows Hexclad and Xtradur lines of long-life clad soldering tips, both plug and screw tip types, for all makes.—Hexacon Electric Co., 179 W. Clay Ave., Roselle Park, N. J.

Circle **502** on inquiry card.



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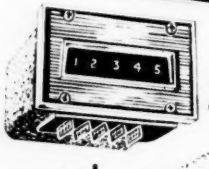

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Aero Research Instrument Company, Inc. 1114
A'G'A Division of Elastic Stop Nut Corp. of America 1104
American Chain & Cable Co., Inc. Helicoid Gage Division 1083
American Time Products, Inc. 1024
AMP Incorporated 989
Annin Company 977
Autotron, Inc. 1104
Autron Engineering, Inc. 1118

Bailey Meter Company 1022
Baird-Atomic, Inc. 992
Barksdale Valves 1000
Beckman/Berkeley 1116
B-I-F Industries, Inc., Builders-Providence Inc. 1072, 1073
B-L-H: Electronics & Instrumentation Division 1023
Brailsford & Co., Inc. 1112
Bridgeport Thermostat Division 964
Bristol Company 986, 1116
Builders-Providence, Inc. B-I-F Industries, Inc. 1072, 1073
Burroughs Tube Division 1009

Chester Cable Corp. 1015
Clary Corporation 1093
Comar Electric Company 1103
Concord Control, Inc. 1100
Conoflow Corporation 1029
Consolidated Electrodynamics Corporation 969, 993, 1017
Cox Instruments Division, George L. Nankervis Co. 1107
Crescent Insulated Wire & Cable Co. 1020
Curtiss-Wright Corporation 974

Dahl Company, Inc., George W. 1016
Delanium Graphite Division Kearney Industries 1096
Diehl Manufacturing Company 1091
Du Mont Laboratories, Inc., Allen B. 1001, 1002

Eagle Signal Corporation 1011
Eastern Air Devices, Inc. 1003
Electronic Associates, Inc. 1062
Eppley Laboratory, Inc. 990
Epsco Incorporated 1109
Esterline-Angus Company, Inc. 1098

Farris Engineering 1059
Fenwal Incorporated 976
Fisher Governor Company 1012, 1013
Foxboro Company 982, 983, 987
Fulton Sylphon Division 971

General Electric Company 972
Gilbert & Baker Mfg. Co. 1116
GPS Instrument Co., Inc. 1067
Gray Instrument Company 1108
Gubelman Charts Incorporated 1102

Hammel-Dahl Company Back Cover
Hasler-Tel Co., Inc. 1112
Heiland Division, Minneapolis-Honeywell Regulator Co. 1008
Helicoid Gage Division American Chain & Cable Co., Inc. 1083
Heise Bourdon Tube Company, Inc. 1111
Hoke Incorporated 1077

Illinois Testing Laboratories, Inc. 1104
Imperial Brass Mfg. Co. 991
Imtra Corporation 1110
Industrial Electronic Engineers 980
Industrial Instruments Inc. 1113
Instrument Service Engineering Labs. 1116
Instruments Publishing Co. 1004, 1028, 1078, 1101, 1115

Jones Optical Works, A. D. 1102

Kearney Industries Delanium Graphite Division 1096
Kin-Tel 995, 1021
Klipfel Valves, Inc. 960
Kurman Electric Co. 1096

Leeds & Northrup Company 1030
Leslie Co. 1052
Levin & Son, Inc., Louis 1081
Lewis Engineering Co. 959
Librascope, Inc. 985
Linde Company Division of Union Carbide Corporation 1085
Lynn, Robert M. 1092

Magnetrol Valve Corp. 1110
Manning, Maxwell & Moore, Inc. 966, 967, 1005, 1027, 1071
Marsh Instrument Co. 1105
Marshalltown Mfg. Company 1081
Mercoid Corporation 1090
Measurements Corporation 1114
Midwestern Instruments 994
Mine Safety Appliances Company 997
Minneapolis-Honeywell 970, 996, 1025, 1069
Moeller Instrument Company 988
Monroe Calculating Machine Co. 973
Moser Jewel Company 1105

Nankervis Co., Geo. L., Cox Instruments Div. 1107
Nash Engineering Company 1075
National Pneumatic Co., Inc. 1099
Northam Electronics, Inc. 1079
Norwood Controls 981

Optics Manufacturing Corp. 1079
Opto-Metric Tools, Inc. 1103

Panellit, Inc. 1058
Partlow Corp. 962
Petrometer Corporation 1103
Philbrick Researches, Inc., Geo. A. 1018
Post Electronics Division of Post Machinery Co. 1094
Precision Tube Company 1088
Preis Engraving Machine Co., H. P. 1096
Production Instruments Division of General Controls Co. 1086
Pyro Service Company 1116

Radio Frequency Laboratories, Inc. 965, 1082
Reeves Soundcraft Corp. 1097
Renick Co., L. C. 1106
Rockwell Company, W. S. 1084

Sanborn Company 1006, 1007
Scherr Co., Inc., George 1105
Sensitive Research Instrument Corporation 960
Shallcross Manufacturing Company 1087
Shore Instrument & Mfg. Co., Inc. 1098
Simplatrol Products Corp. 1108
Skinner Electric Valve Division 1019
Smith Co., S. Morgan 1117
Sorensen & Company, Inc. 979
Southwestern Industrial Electronics Company 1003
Standard Electric Time Company 1094
Staplex Co., The 1097
Stewart Corp., F. W. 1112
Stromberg-Carlson 1014
Superior Tube Company 968
Swartwout Company 963
Swiss American Jewel Bearings Co. 1079

Technique Associates, Inc. 1102
Testa Manufacturing Company 1098
Thermo Electric Co., Inc. 1095

Unertl Optical Co., John 1106
Union Carbide Corporation Division of Linde Company 1085
United Electric Controls Company 1077
United States Testing Machine Co. Inside Front Cover
Universal Electronics Company 1081

Van Products Co. 1114
Veeder-Root Incorporated Inside Back Cover

Wallace & Tiernan Incorporated 1089
Waterman Products Co., Inc. 1026
Waugh Engineering Co. 1010
Weston Electrical Instrument Corporation, a Subsidiary of Daystrom, Incorporated 998, 999
Wiancko Engineering Company 1078

NEW LITERATURE

WIRE, CABLES

WIRE AND CABLE. 6-page short form catalog folder describes line of Teflon-insulated wire and cable.—American Super-Temperature Wires, Inc., Winooski, Vt.

Circle 503 on inquiry card.

TRAILER CABLES. 4-page brochure describes trailer wires and cables, covers Motoprene wires, thermoplastic, rubber-covered cord and brake cables.—Essex Wire Corp., 1601 Wall St., Fort Wayne, Ind.

Circle 504 on inquiry card.

MECHANICAL COMPONENTS

COMPONENTS. 28-page pocket Catalog Supplement 15 covers miniature ball bearings, worm-and-wheel assemblies, helical-gear assemblies, magnetic clutches, etc.—PIC Design Corp., East Rockaway, L. I., N. Y.

Circle 505 on inquiry card.

RETAINING RINGS. 16-page engineering specifications catalog covers expanded line of industrial retaining rings.—Dept. PB-77, Industrial Retaining Ring Co., 57 Cordie St., Irvington 11, N. J.

Circle 506 on inquiry card.

MINIATURE BEARINGS. 6-page Catalog Supplement M1 describes extended line of precision miniature ball bearings including full range of smaller sizes introducing superior performance characteristics available for the first time.—The Barden Corp., Danbury, Conn.

Circle 507 on inquiry card.

INSTRUMENT BEARINGS. 4-page Bulletin describes the new Microwafers for manufacturers of synchros, servos, small motors, potentiometers and gear trains.—New Hampshire Ball Bearings, Inc., Peterborough, N. H.

Circle 508 on inquiry card.

SELF-SEALING FASTENERS. 4-page Catalog H describes and illustrates a line of high-pressure self-sealing Seelskrews, Seelbolts, and Seelrivits for industrial and military use.—Automatic and Precision Mfg. Co., 252 Hawthorne Ave., Yonkers, N. Y.

Circle 509 on inquiry card.

MATERIALS

GLASS-METAL SEALS. 4-page bulletin describes Rodar, Niron 46, and Niron 52 sealing alloys.—Wilbur B. Driver Co., 1875 McCarter Hwy., Newark 4, N. J.

Circle 510 on inquiry card.

MAN-MADE SAPPHIRES. 4-page bulletin titled "Properties and Uses of Linde Sapphire" gives properties, etc.—Linde Co., Div. Union Carbide Corp., 30 East 42nd St., New York 17, N. Y.

Circle 511 on inquiry card.

PLASTICS. 64-page catalog of plastic sheets, rods, tubes, films, and layflat tubings; also cements, pigments and miscellaneous supplies; lists available sizes, weights, color ranges, textures, specs; includes 2-page comparison table of chemical, electrical,

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2	22	42	62	82	102	122	142
3	23	43	63	83	103	123	
4	24	44	64	84	104	124	
5	25	45	65	85	105	125	
6	26	46	66	86	106	126	
7	27	47	67	87	107	127	
8	28	48	68	88	108	128	
9	29	49	69	89	109	129	
10	30	50	70	90	110	130	
11	31	51	71	91	111	131	
12	32	52	72	92	112	132	
13	33	53	73	93	113	133	
14	34	54	74	94	114	134	
15	35	55	75	95	115	135	
16	36	56	76	96	116	136	
17	37	57	77	97	117	137	
18	38	58	78	98	118	138	
19	39	59	79	99	119	139	
20	40	60	80	100	120	140	

Products Reported Editorially

201	221	241	261	281	301	321	341	361	381	401	421	441	461	481	501
202	222	242	262	282	302	322	342	362	382	402	422	442	462	482	502
203	223	243	263	283	303	323	343	363	383	403	423	443	463	483	503
204	224	244	264	284	304	324	344	364	384	404	424	444	464	484	504
205	225	245	265	285	305	325	345	365	385	405	425	445	465	485	505
206	226	246	266	286	306	326	346	366	386	406	426	446	466	486	506
207	227	247	267	287	307	327	347	367	387	407	427	447	467	487	507
208	228	248	268	288	308	328	348	368	388	408	428	448	468	488	508
209	229	249	269	289	309	329	349	369	389	409	429	449	469	489	509
210	230	250	270	290	310	330	350	370	390	410	430	450	470	490	510
211	231	251	271	291	311	331	351	371	391	411	431	451	471	491	511
212	232	252	272	292	312	332	352	372	392	412	432	452	472	492	512
213	233	253	273	293	313	333	353	373	393	413	433	453	473	493	513
214	234	254	274	294	314	334	354	374	394	414	434	454	474	494	514
215	235	255	275	295	315	335	355	375	395	415	435	455	475	495	515
216	236	256	276	296	316	336	356	376	396	416	436	456	476	496	516
217	237	257	277	297	317	337	357	377	397	417	437	457	477	497	517
218	238	258	278	298	318	338	358	378	398	418	438	458	478	498	518
219	239	259	279	299	319	339	359	379	399	419	439	459	479	499	519
220	240	260	280	300	320	340	360	380	400	420	440	460	480	500	520

and mechanical properties.—Cadillac Plastic & Chemical Co., 15111 Second Ave., Detroit 3, Mich.

Circle 512 on inquiry card.

FOAMED PLASTICS. A set of brochures on rigid, semi-rigid and flexible Stafoam polyurethanes for instrumentation industry.—American Latex Products Corp., 3341 W. El Segundo Blvd., Hawthorne, Calif.

Circle 513 on inquiry card.

GLASS. 32-page Application Handbook titled "Glass—to Brighten Your Product's Future," covers many types of glass now available, outlines various forming processes and finishing operations which make possible new design concepts.—Lancaster Glass Corp., Lancaster, Ohio.

Circle 514 on inquiry card.

STEEL FOR TRANSFORMERS, etc. 16-page Blue Data Sheet covers Silectron grain-oriented cold-rolled 3% silicon steel; has two tables, ten graphs, data as to typical curves, grading, annealing cycle, etc.—Allegheny Ludlum Steel Corp., Oliver Bldg., Pittsburgh 22, Pa.

Circle 515 on inquiry card.

FACILITIES

ELECTRONIC R & D. 4-page bulletin describes company's facilities for research, design, and manufacture of specialized high-quality ultrasonic solid delay lines.—Anderson Labs. Inc., 501 New Park Ave., West Hartford, Conn.

Circle 516 on inquiry card.

FACILITIES AND PRODUCTS. 20-page brochure describes company's facilities and activities in design and manufacture of specialized electronic equipment.—Jackson Electronic & Mfg. Co., 695 Johnston St., Akron 6, Ohio.

Circle 517 on inquiry card.

FABRICATION, SHOP EQUIPMENT

TRACER CONTROL. 8-page Bulletin GET-2736A describes GE's two-dimension tracer control, featuring technical notes on operation, design and experience of tracing performance.—General Electric Co., Schenectady 5, N. Y.

Circle 518 on inquiry card.

LEAK DETECTION. 8-page brochure describes nitrous oxide installations specifically designed for use in leak detection of pressurized systems.—Ohio Chemical & Surgical Equipment Co., 1400 East Washington Ave., Madison 10, Wisc.

Circle 519 on inquiry card.

GLASS PRODUCTS. 8-page Catalog 80-23 discusses fabrication, materials, tolerances and applications of precision glass products.—Fischer & Porter Co., 691 Jacksonville Rd., Hatboro, Penna.

Circle 520 on inquiry card.

ZONE MELTING. 4-page Bulletin 2470 describes new apparatus for zone refining, zone leveling, crystal pulling, etc.—Research Specialties Co., 2005 Hopkins St., Berkeley 7, Calif.

Circle 521 on inquiry card.

X-RAYS etc. 64-page Catalog W-58 on x-ray accessories, isotope and inspection equipment, radiation protection and film processing equipment gives specs and product information; includes 20 full-color Pamelon finishes.—Bar-Ray Products, Inc., 209-25th St., Brooklyn 32, N. Y.

Circle 522 on inquiry card.

BONDED COATINGS. 24-page pocket-size Bulletin 115 covers, in detail, preparation of metal surfaces for proper application of Molykote resin-bonded lubricant coatings.—The Alpha-Molykote Corp., 65 Harvard Ave., Stamford, Conn.

Circle 523 on inquiry card.

LAPPING MACHINES. 4-page Catalog Section lists detailed data and specs of maker's five standard model lapping machines.—Syntron Co., 702 Lexington Ave., Homer City, Penna.

Circle 524 on inquiry card.

AIR TOOLS. 2-page bulletin describes new addition to Kellerflex line for burring, sanding, grinding, and polishing.—Pratt & Whitney Co., Inc., Charter Oak Blvd., West Hartford 1, Conn.

Circle 525 on inquiry card.

MISCELLANEOUS

PARTS CLEANERS. 4-page brochure describes automatic precision-parts cleaners using high-velocity spray clean technique.—Cobehn Inc., Passaic Ave., Caldwell, N. J.

Circle 526 on inquiry card.

ULTRASONIC CLEANING Equipment available in building blocks is described in 2-page Bulletin BB-100.—Acoustica Assocs., Inc., 26 Windsor Ave., Mineola, L. I., N. Y.

Circle 527 on inquiry card.

DRAFTING AID. 24-page Catalog E-58 covers "Tech-Tac" in which pre-printed symbols on clear acetate eliminate hand drawing and inking of repetitive electrical and electronic symbols.—Tech-Tac Inc., 727 W. 7th St., Los Angeles 17, Calif.

Circle 528 on inquiry card.

INSTRUMENT MOUNTINGS. 4-page Bulletin 601 describes in detail a low-cost bonded-rubber mounting for protecting sensitive instruments against shock and vibration.—Lord Mfg. Co., Erie, Penna.

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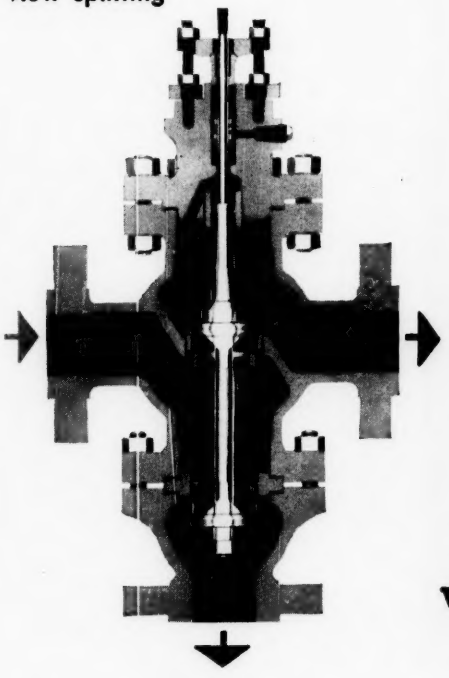
in
THREE-WAY VALVES

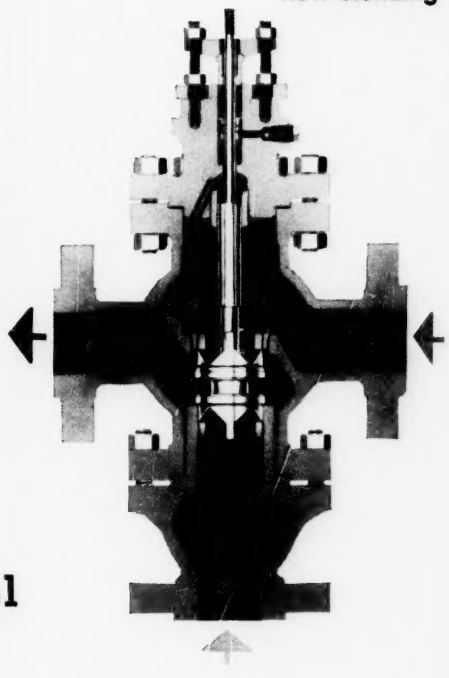
hammel-dahl offers

3000-QQ
flow splitting



1
answer
FOR THE
2
types
OF
3
way control

3000-Q
flow blending



SIMPLICITY . . . The one basic valve construction adapts to either flow blending or flow splitting control — through the feature of interchangeable plugs and lower seats (retained — no threads).

STABILITY . . . Direction of flow tends to unseat the plug heads — insuring stability over complete valve travel at maximum allowable pressure drop.

CAPACITY . . . Highest Cv of any Three-Way control valve. Both seats identical in area. Full flow capacity obtainable through either seat.

For complete information, write for our 1958 catalog.

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